500 Boylston Street Project

BRA Final Environmental Impact Report

February 1985

ubmitted to — Boston Redevelopment Authority

roject Proponent — A Joint Venture of
New England Mutual Life Insurance Company
Gerald D. Hines Interests, Inc.

repared by — Skidmore, Owings & Merrill
Vanasse/Hangen Associates, Inc.
Haley & Aldrich, Inc.
Tech Environmental
Wright Brothers Facility, MIT
Historic Preservation Planning & Analysis

500 Boylston Street Project

BRA Final Environmental Impact Report

February 1985

Submitted to	Boston Redevelopment Authority
Project Proponent	A Joint Venture of New England Mutual Life Insurance Company Gerald D. Hines Interests, Inc.
Prepared by	Skidmore, Owings & Merrill Vanasse/Hangen Associates, Inc. Haley & Aldrich, Inc. Tech Environmental Wright Brothers Facility, MIT Historic Preservation Planning & Analysis

Contents

I Summary 1
- 500 Boylston Street Project 1
- Development Alternatives 1
  - Alternative 1: No-Build 1
  - Alternative 2: 500 Boylston Street Project 2
- Proponent 3
- BRA EIR Status 3
- Summary of Environmental Issues 3
  - Transportation 3
  - Air Quality 4
  - Natural Resources 5
  - Historic/Visual Quality 6
  - Wind 7
  - Shadow 7
  - Archaeology 8

II Project and Area Description 9
- Project Description 9
  - Project Benefits 11
- Area Description 12
  - Back Bay 12
  - South End 14
  - Park Square 15
  - Future Development in the Area 15
- Permits 16

III Description of Alternatives 17
- Alternative 1: No-Build 17
- Alternative 2: 500 Boylston Street Project 18

IV Environmental Issues Comments and Responses 21
- Comments 23
  - BRA Comments and Public Review Letters 25
- Transportation 45
  - Introduction 45
  - Responses 46
- Air Quality 83
  - Introduction 83
  - Responses 83
- Natural Resources 91
  - Introduction 91
  - Responses 91
- Historic/Visual Quality 97
  - Introduction 97
  - Responses 97

Wind 103
Introduction 103
Responses 104
Shadow 127
Introduction 127
Responses 138
Archaeology 141
Status Report 141

V Measures to Mitigate Adverse Effects 143
Transportation 143
Air Quality 144
Natural Resources 144
Historic/Visual Quality 144
Wind 144
Shadow 145
Archaeology 145

Appendices

Appendix 1: Environmental Notification Form Including Scope Statement for the BRA EIR
Appendix 2: Transportation
Appendix 3: Wind*
Appendix 4: Shadow Study: Clarendon Street Playground*
Appendix 5: Archaeology*

* Appendices 3, 4, and 5 are available on request from Skidmore, Owings & Merrill (617-247-1070).

List of Exhibits

EXHIBIT	TITLE	PAGE
II-1	Locus Map: 500 Boylston Street, Boston, MA	10
II-2	Surrounding Areas	13
III-1	Ground Floor Plan	19
IV-1	Summary of Effects of Constrained Parking and Improved Traffic Operations at Selected Intersections	48
IV-2	Tent City Project Intersections Level of Service Analysis for 1989 Build PM Peak Hour	51
IV-3	Historical Volume Trends for Back Bay/South End Stations	58
IV-4	Historical Volume Trends for Back Bay Roadways	59
IV-5	Historical Volume Trends for Back Bay Intersections	60
IV-6	Level of Service Criteria for Signalized Intersections	64
IV-7	Pedestrian Level of Service Summary Analysis	70
IV-8	Existing AM Peak Hour Volumes	76
IV-9	Level of Service and Expected Delay for Reserve Capacity Ranges	79
IV-10	Predicted Maximum CO Concentrations (PPM), Plus Background, at 12 Project Area Intersections	85
IV-11	Site Historic Context	100
IV-12	Comparison of Annual Velocities for the Project	107

EXHIBIT	TITLE	PAGE
IV-13	Comparison of Annual Velocities for Revised Design	108
IV-14	Melbourne's Category at Each Station	110
IV-15	28 Stations Tested for Existing Conditions	111
IV-16	32 Stations Tested for Project	112
IV-17	Comparison, Annual and Seasonal 100-Hr. Return Period Velocities for Existing Conditions and Proposed Project	114
IV-18	Predicted Wind Conditions With Proposed Revised Project Design (As Compared to Existing Conditions)	116
IV-19	Tree Configuration Numbers 1, 2 and 3	118
IV-20	Comparison of Annual Velocities for Tree Configurations with Revised Project Design	119
IV-21	Melbourne's Criteria for 100-Hour Return Period	122
IV-22	Comparison of Criteria for Acceptable 100-Hour Return Wind Velocities	122
IV-23	Boston Wind Roses	125
IV-24	Spring and Fall Equinoxes (September 21) 9:00 AM, 12:00 noon, 3:00 PM	129
IV-25	Summer Solstice (June 21) 9:00 AM, 12:00 noon, 3:00 PM	132
IV-26	Winter Solstice (December 21) 9:00 AM, 12:00 noon, 3:00 PM	135

I Summary

500 BOYLSTON STREET PROJECT

This Final Environmental Impact Report (EIR) examines a no-build alternative and a mixed-use development alternative for 500 Boylston Street, in the City of Boston and Suffolk County. Located in the Back Bay, the 3.15-acre project site is bounded by St. James Avenue and Clarendon, Boylston, and Berkeley Streets, with a portion of Providence Street traversing the site between Berkeley and Clarendon Streets. The northern portion of the site, bordered by Providence, Clarendon, Boylston, and Berkeley Streets, is occupied by office and retail buildings owned by the New England Mutual Life Insurance Company. The southern portion of the block, bounded by St. James Avenue and Clarendon, Providence, and Berkeley Streets, contains the City-owned St. James Avenue Garage.

As in the Draft EIR, submitted to the Boston Redevelopment Authority (BRA) in October 1984, Chapters I-III of this Final EIR describe the project alternatives, summarize the environmental issues associated with the proposed project, and provide project and area descriptions. Chapter IV, Environmental Issues, responds to a series of written comments from the BRA on the environmental analyses presented in Chapter IV of the Draft EIR. These comments, which include requests for clarification, elaboration, and in some cases further analysis, resulted from the Authority's in-house staff review and from letters submitted during the public review period. Chapter V, a summary of mitigation measures, has been updated to reflect additional measures considered since the Draft EIR. Appendix 1 reproduces the Environmental Notification Form originally submitted for the proposed project and along with the scoping statement of the environmental issues to be examined for the BRA. Appendices 2, 3, 4, and 5 present technical data on further analyses conducted for transportation, wind, shadow, and archaeology since publication of the Draft EIR.

DEVELOPMENT ALTERNATIVES

Alternative 1: No-Build

The no-build alternative assumes the continuation of existing structures and uses. The seven buildings fronting on Boylston Street represent a variety of architectural styles and are between three and seven stories high. Typically, retail uses occupy the ground floors, with offices located on the upper levels. It

is likely that a mix of retail and office uses will continue under this alternative.

The St. James Avenue Garage, on the southern portion of the site, provides 625 public parking spaces. A site inspection by structural engineers indicates the garage, built in 1953, is in need of rehabilitation. The continuation of public parking at this above-ground garage is assumed under this alternative, with the likelihood of some interruption of service for repairs.

Alternative 2: 500 Boylston Street Project

With the proposed project alternative, the St. James Avenue Garage, the segment of Providence Street that runs through the site, and underground portions of adjacent streets would be conveyed by the City of Boston to a joint venture of New England Mutual Life Insurance Company and Gerald D. Hines Interests, Inc. in order to implement a full-block integrated redevelopment plan. The BRA, in its capacity as planning board for the City, selected the plan subsequent to solicitation for development proposals for the garage site. The proposed development will enable the corporate expansion of New England Life to occur across the street from its present headquarters at 501 Boylston Street. The 500 Boylston Street Project will establish an active mixed-use development consisting of offices, retail stores, restaurants, other commercial uses, pedestrian plazas and walkways, and a below-grade parking garage.

The mixed-use project is the preferred alternative and is generally consistent with standards proposed by the Back Bay Federation for Community Development (a standing organization representing neighborhood and business associations) and with guidelines established by the BRA for the development of the St. James Avenue Garage parcel. At the inception of the design review process, the BRA formed the St. James Avenue Civic Advisory Committee (CAC) to represent Back Bay and South End community interests. Recommendations of this citizen's group have been adopted by the City, the BRA, and the proponent to further enhance the project's responsiveness to the surrounding communities. The CAC will continue to be involved in an advisory capacity throughout the project's construction phase.

PROPONENT

A joint venture of New England Mutual Life Insurance Company and Gerald D. Hines Interests, Inc. (Hereafter referred to as the proponent.)

BRA EIR STATUS

Final.

(In addition to the BRA Final EIR, a MEPA Final EIR that addresses potential sewerage impacts of the project will be submitted to the Massachusetts Executive Office of Environmental Affairs.)

SUMMARY OF ENVIRONMENTAL ISSUES

The environmental effects of project implementation and the no-build alternative are briefly described below. Chapter IV and the Appendices should be referred to for a more detailed discussion of these issues.

Transportation

In 1989, the project is expected to generate about 7,300 new person-trips daily (each way), about 40 percent by vehicle, 48 percent via public transportation, and 12 percent on foot. New vehicle trips produced during the AM and PM peak hours are estimated to be 530 and 624 trips, respectively.

In the morning peak hour, four of the 23 intersections analyzed will have poorer levels of service (LOS) with the project. However, no intersections are estimated to operate at LOS E (capacity) during the AM peak hour. During the evening peak, service levels will be lower at five intersections with the project, but only one of these is estimated to be at LOS E (Berkeley Street/Boylston Street). With or without the project, two other intersections will also operate at LOS E. These are Berkeley Street/Beacon Street and Arlington Street/Stuart Street/Columbus Avenue.

Future parking supply at 500 Boylston Street will be approximately 1,000 spaces. The proponent is seeking to implement a 300 space expansion of the National Garage, which is owned and operated by New England Life. When compared with existing and future demand at

these two garages, there is a predicted shortfall of 375 long-term spaces and a surplus of 100 short-term spaces. In the event that the expansion space is not available at the National Garage, the predicted shortfall would be 675 spaces. The proponents would consider a valet/attendant parking program at the 500 Boylston Street garage to help reduce this shortfall. As noted in the Draft EIR, the traffic analysis considered a scenario in which the 300 parking spaces from the National Garage were accommodated in the 500 Boylston Street garage. The analyses showed little difference in volume-to-capacity ratios at the study area intersections, and virtually no difference in level of service. It is believed that a shift to public transportation modes, combined with an increase in vehicle occupancy rates, will lessen the effects of the long-term parking shortage.

New project-generated public transit trips are expected to total about 1,540 during the PM peak hour in 1989. However, the expanded service into the new Back Bay Station on the relocated Orange Line, along with Green Line equipment purchases and improvements, will leave sufficient unused peak hour capacity on both lines to handle projected ridership levels.

Air Quality

Ambient air quality was assessed by performing a microscale analysis of carbon monoxide (CO) concentrations at 12 nearby roadway intersections and in public areas adjacent to the proposed locations of the exhaust vents for the project's parking garage and the nearby National Garage. The analysis examined existing (1984) conditions as well as the no-build and project alternatives in the horizon year (1989).

Modeling results indicate that violations of the National Ambient Air Quality Standards (NAAQS) currently exist at 10 of the 12 intersections. Under the 1989 no-build alternative, NAAQS violations will be eliminated at all intersections except one as a result of continued enforcement of the State's Inspection and Maintenance Program and the trend toward cleaner vehicle emissions. If the project is implemented, violations will occur in 1989 at three additional inter-

sections. Two mitigation measures have been identified that--in conjunction with the continuation of the Commonwealth's Inspection and Maintenance Program for motor vehicles--would eliminate violations for one-hour and eight-hour CO concentrations for both alternatives in 1989. These include: (i) extending the peak hour parking ban to a 24-hour ban on the Arlington Street block between St. James Avenue and Columbus Avenues; and (ii) balancing the traffic signal cycle for three intersections on Berkeley Street during off-peak hours. With these mitigation measures, the proposed development will not interfere with the attainment and maintenance of the NAAQS for CO.

Natural Resources

For construction of the project foundations and the below-grade parking structure, an excavation approximately 40 feet deep will be made through the fill and organic soils to the top of the stiff clay stratum. A lateral earth support system will be used to support the sides of the excavation to prevent significant ground movements outside the excavation limits. Some minor ground movements will occur outside the excavation but are expected to dissipate within 40 to 60 feet from the project site and should not result in damage to adjacent buildings or underground utilities. The lateral earth support system will also serve to minimize groundwater drawdown outside the site during construction.

Building loads will be supported on reinforced concrete mats and spread footings bearing on the stiff clay crust. Piles driven to end-bearing will not be used to support building loads. Short friction piles may be used to help resist buoyant forces due to groundwater in the plaza area. Vibrations, noise, and ground movements associated with friction pile installation would be significantly lower than those for bearing piles.

Based on measured groundwater levels, the relative locations and nature of buildings and utilities around the site, and results of computer-aided analyses, it is believed that any long-term changes in groundwater

levels outside the site due to the proposed project will be small and will not adversely affect existing buildings or other facilities.

Measures to minimize potential impacts of constructing the below-grade portions of the proposed development on area groundwater levels and adjacent structures are planned for each aspect of the construction. Specified construction performance criteria and careful monitoring of construction performance will be employed. In the event that the construction results in ground movements or changes in groundwater levels larger than specified limits, pre-determined mitigation measures will be employed.

Historic/Visual Quality

The architecture and urban design of the proposed 500 Boylston Street project attempts to respect the design traditions of the surrounding Back Bay area while retaining its identity as a modern building. The historic context for the 500 Boylston Street Project includes areas and buildings whose historic importance has been identified by federal, state and local agencies. The site itself is in a transition area between mid-rise structures along Boylston Street and high-rise structures to the south of the site, which are part of Boston's "high spine." Recognizing the complexity and sensitivity of the site's historic/visual context, the proponent and its architects have participated in a continuing design review process in consultation with the BRA and the St. James Avenue CAC.

The project design acknowledges major architectural features of nearby historic buildings. The massing of the building, its relationship to the streetscape (both in design and selection of streetfront uses), the facade design, and selection of quality facade materials are intended to identify this project as a new building that respects the historic character of its surroundings. Impacts of the proposed project on the visual environment were analyzed through a series of eye-level views presented in the Draft EIR. This analysis highlighted elements of massing, streetscape treatment, and facade design as referenced in surrounding historic and other prominent surrounding buildings.

Wind

An analysis of wind conditions on the project site and the surrounding area was conducted at the Wright Brothers Wind Tunnel facility at the Massachusetts Institute of Technology. A preliminary study was conducted in February 1983 using a wind erosion test. A second test using the hot-wire anemometer method was conducted in May 1984 as required by the scope for the BRA EIR process. Following submission of the BRA Draft EIR, a second hot-wire test was performed in December 1984. The evaluation of the data obtained from this second hot-wire test is presented in this BRA Final EIR.

Two sets of comfort criteria were used for evaluation of the data collected at the wind tunnel. The first is a guideline used by the BRA that establishes a threshold magnitude for pedestrian-level effective peak gust velocities not to be exceeded more than one percent of the time. The second is an international standard compiled and published by W. H. Melbourne that sets categories of relative comfort for pedestrians and a set of corresponding wind velocity magnitudes.

Pedestrian-level wind velocities on the project site and in the surrounding areas will not change significantly, and in some cases may improve slightly, as measured by either the BRA Guideline or Melbourne's comfort criteria. Analyses of both the data obtained from the hot-wire tests and the earlier erosion test conclude that with the construction of the 500 Boylston Street Project, all pedestrian-level wind conditions on the site will remain within the BRA Guideline. In the surrounding areas, wind conditions will improve slightly and no additional test stations will exceed the BRA Guideline.

Shadow

The effects of shadows cast by the proposed project were analyzed for four principle areas: (i) the Boylston Street pedestrian and retail area; (ii) Copley Square; (iii) Commonwealth Avenue Mall; (iv) Clarendon Street Playground; and (iv) the pedestrian open space plazas in the 500 Boylston Street Project. Shadow conditions were studied at four times of the year--at

the Spring and Fall Equinoxes, the Summer Solstice, and the Winter Solstice. The analysis revealed that the Boylston Street pedestrian and retail area will experience a small increment of new morning and afternoon shadow in the fall, winter, and spring as a result of the proposed project. Copley Square will experience a small increase of shadow coverage in the northeast corner of the Square in the early morning hours during spring, summer, and fall months. During winter mornings, new shadows will be cast on the north side of Commonwealth Avenue. New shadows cast by the proposed project on the Clarendon Street Playground will occur in the late fall, as well as during the winter months. Partial shading of the playground during this period will occur for a duration of less than 15 minutes to more than 45 minutes between 8:00 AM and 9:45 AM. The 500 Boylston Street open space plazas will be in direct sunlight during summer afternoons, but will be in shadow for the rest of the year.

Archaeology

The project site may contain the remains of a native American fishweir estimated to have been built between 4,500 and 6,000 years ago. Although the location and condition of these remains is not yet known, their possible presence makes this an important archaeological site. Mitigation of impacts to archaeological resources will be accomplished through the excavation and analysis of the site during project construction. The reconnaissance effort to establish the scope of the resource recovery program has begun. Two core samples from Providence Street have been recovered and are undergoing analysis. The library research on coastal fishweirs has been completed. Appendix 5 presents a status report on the reconnaissance work underway. The proponent is committed to facilitating the recovery and interpretation of significant archaeological data at the site.

II Project and Area Description

PROJECT DESCRIPTION

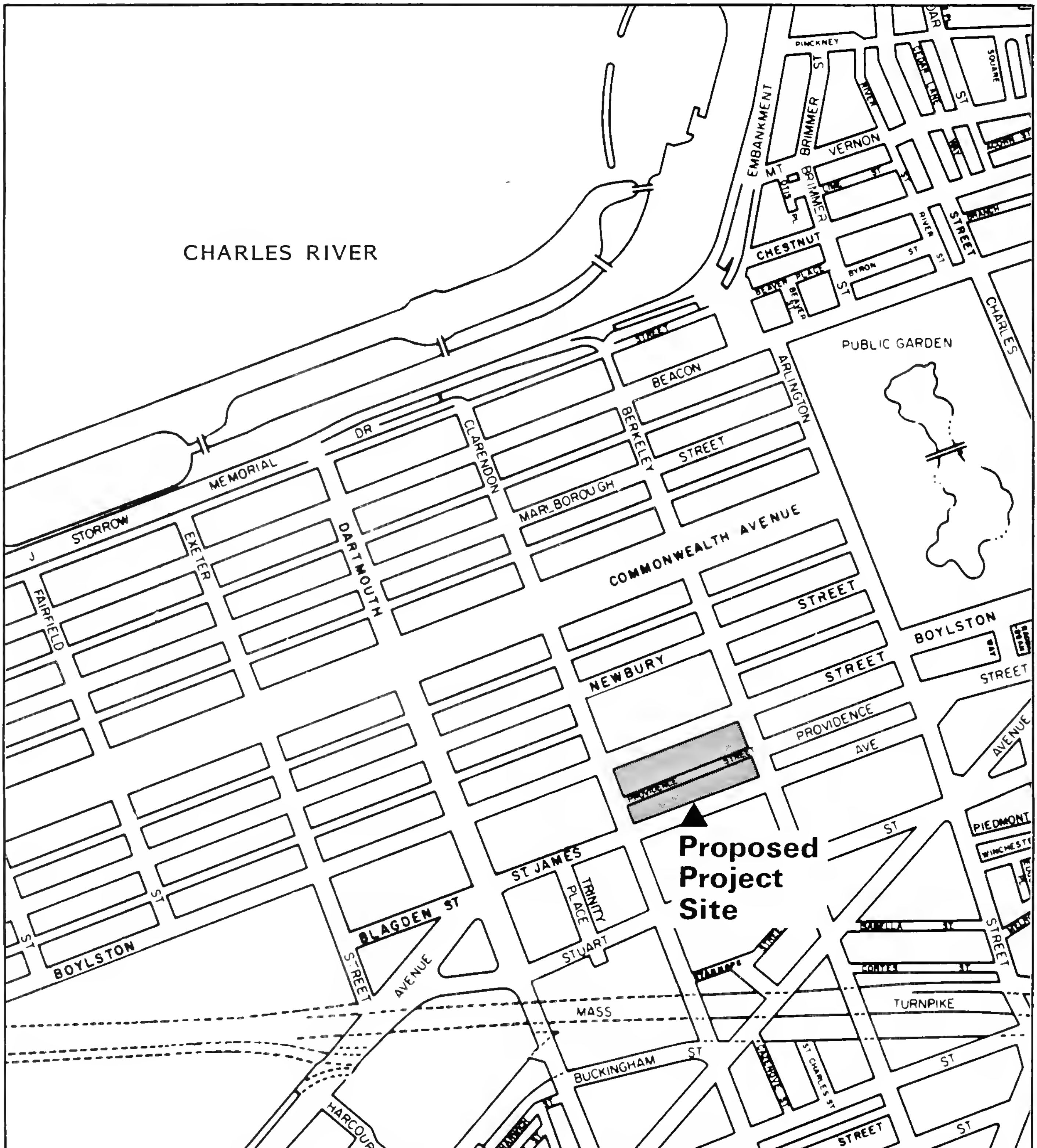
The 3.15-acre project site is composed of public and private parcels that together comprise the block bounded by St. James Avenue and Clarendon, Boylston, and Berkeley Streets. The public property consisting of the St. James Avenue Garage parcel and the portion of Providence Street running through the site make up a total area of 69,191± square feet on the southern side of the site. To the north, the land and buildings fronting Boylston Street are owned by the New England Mutual Life Insurance Company. Exhibit II-1 identifies the location of the project site.

The block constituting the site was created as part of the original Back Bay landfill and grid development of the mid-nineteenth century. Boylston Street, which bounds the block on the northern side, was one of the principle roadways in the rectangular grid of longitudinal blocks. Historically, the street has been characterized by buildings containing specialty retail shops on the ground floors with residential, hotel, or office space on the upper levels. The seven buildings fronting Boylston Street on the site today house retail and office uses. The only structure occupying the public parcels on the south side of the site is the St. James Avenue Garage, which is owned and operated as a public parking facility by the City of Boston. In November 1982, the BRA, on behalf of the City, advertised the sale of the 56,541± square foot garage parcel for development, with an opportunity to include the 12,650± square foot portion of Providence Street that traverses the site.

The proposed City action consists of disposition of the publicly owned parcels to the proponent, thereby allowing the implementation of a full-block, integrated plan for an active, 1.3 million square foot, mixed-use development. Pedestrian plazas and walkways will be integrated with a six-story base structure fronting Boylston Street, providing approximately 100,000 square feet of retail and commercial space in the lower stories and offices in the upper floors. Most of the 1.2 million square feet of office space will be accommodated in two towers rising 19 stories from the 6-story base at the southern end of the project site, resulting in a maximum project height of 25 stories. Sidewalks will be widened on Clarendon Street, St. James Avenue,

EXHIBIT II-1

Locus Map
500 Boylston Street
Boston, Massachusetts



(Parcel is bounded by Clarendon, Boylston, and Berkeley Streets and St. James Avenue)

and a portion of Berkeley Street, with perimeter landscaping provided on all four sides of the site. An underground parking garage, with access and egress on St. James Avenue and Berkeley and Clarendon Streets, will replace the 625 public spaces currently provided by the St. James Avenue Garage. An additional 375 spaces will be designated for use by the tenants of the project. The massing, detailing, and materials of the proposed project are designed to relate to historic Back Bay building elements and the area's pedestrian orientation and scale.

Construction is scheduled to begin by the end of the second quarter of 1985, with initial occupancy starting in the first quarter of 1987. The entire project, including all site improvements, is scheduled for completion by the third quarter of 1989.

Project Benefits

The proposed mixed-use project will provide significant financial and economic benefits to the City while remaining consistent with overall development guidelines established by the BRA and CAC to assure sensitivity to the area's historic building patterns.

The redevelopment of the St. James Avenue Garage parcel will be an asset to the Back Bay community, upgrading an area presently occupied by a deteriorating, aboveground parking garage and linking it more directly with the active, pedestrian-oriented Boylston Street frontage. Within the block, the sidewalk around the site's perimeter and the project's two courtyards will furnish approximately 55,000 square feet of pedestrian open space.

To complement the upgraded pedestrian open spaces on the project site, the proponent has agreed to contribute a significant portion of the funds needed to undertake the redevelopment of the adjacent Copley Square plaza.

The full-block plan will produce significant revenue for the City from the sale of the public parcels (approximately $7.5 million) and from additional new taxes.

In addition, the proponent will make payments totalling approximately $6 million for low to moderate income housing in accordance with the City's policy on linkage between downtown development and neighborhood housing.

The provision in the project for 350,000 square feet of expansion space for New England Life's headquarters will assure the retention of the company's operations, including 1400 permanent jobs, within the City of Boston. With the development of the mixed-use project, more than 3,000 construction-related jobs and more than 4,000 new permanent jobs will be generated.

AREA DESCRIPTION

The 500 Boylston Street project site is situated in an area of the Back Bay that is characterized by a mix of historic and contemporary buildings with predominantly office and retail uses. During daytime working hours, there is active pedestrian circulation throughout the area. Districts neighboring the project site include the residential South End community to the south and Park Square, which features office, retail, and hotel facilities, to the southeast. The plans for the proposed 500 Boylston Street Project have been influenced by the character of the surrounding areas, which are described below and identified in Exhibit II-2.

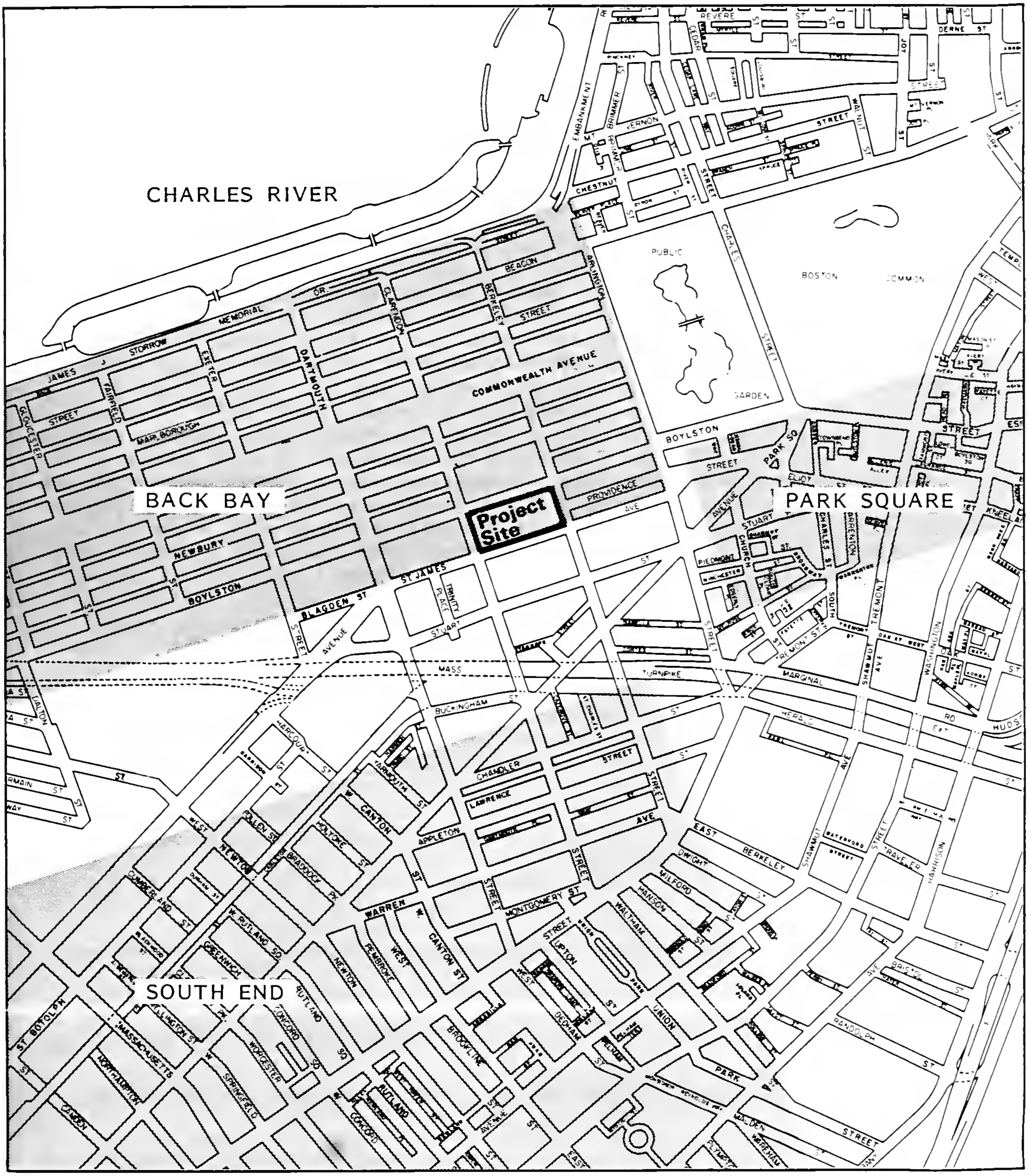
Back Bay

One of the nation's largest land reclamation projects, the Back Bay is located on land filled in the mid-1800s. The Commonwealth Avenue Mall forms the central axis through the Back Bay with Beacon, Marlborough, Newbury, and Boylston Streets serving as the parallel east-west roads. Innovative zoning and building restrictions created a special identity for Back Bay development by establishing a characteristic form and scale while permitting a variety of architectural styles.

Originally the Back Bay was predominantly a private residential area. In the last quarter of the nineteenth century, however, storefronts and office buildings began to replace residences on Boylston and Newbury Streets, with a trend toward larger-scale com-

EXHIBIT II-2

Surrounding Areas



mercial buildings particularly in the area south of Boylston Street to the Massachusetts Turnpike. In the 1960s, the Committee on Civic Design of the Boston Society of Architects (BSA) proposed the "high spine" concept in their report "The Architects' Plan for Boston." This concept was developed to acknowledge the importance of the City's skyline and "to avoid a meaningless mixture of high buildings in areas such as the Back Bay." In the Back Bay, the plan has been to confine the "high spine" to the Boylston Street area. In 1970, the BRA officially recognized the "high spine," which by that time was anchored at the western end of the City by the Prudential Center and the John Hancock Berkeley Building and at the eastern end by the high rises of downtown Boston.

The northern half of the project site, between Boylston and Providence Streets, falls within the Back Bay Historic District as identified on the National and State Registers of Historic Places. Many individual properties within this district have federal, state, or local historic designations, though none are located on the project site. The block west of the site is Copley Square, occupied by Trinity Church and Copley Plaza, while the block to the east across Berkeley Street includes the Berkeley Building and other commercial and retail buildings. On the northern side of Boylston Street, the block is dominated by New England Life's headquarters, with the southeast corner occupied by the original Museum of Natural Science, presently occupied by the Bonwit Teller Company after whom the building is commonly known. To the south, across St. James Avenue between Berkeley and Clarendon Streets, stand the John Hancock Berkeley and Clarendon Buildings.

South End

South of the Massachusetts Turnpike is the South End neighborhood, approximately four blocks from the project site. Planned and developed in the mid-1800s, in part on filled land, this residential area is characterized by brick row houses differing only slightly in detailing and height. Small, family-run storefronts are interspersed throughout the residential streets.

During the 1960s, deteriorating areas were rehabilitated through the Urban Renewal Program. The National

and State Registers identify a 238-acre portion of the South End as a historic district. Recently, this district also received designation as a Local Landmark by the Boston Landmarks Commission. Comprising over one third of the South End, this area is described in the National Register as "the largest remaining Victorian urban residential neighborhood in the United States."

Park Square

After the filling operations of the mid-1800s, the new Back Bay became an immediate neighbor of the area known as Park Square. The project site is located about two blocks from Park Square. Originally private residences dominated this area. In 1835, the addition of a railroad depot stimulated further development in the western portion of Park Square. In the late 1800s, commercial structures began to replace the residential neighborhood. With the relocation of the railroad lines to Boston's South Station in 1900, the square's western area began to be redefined as an important business district featuring the Statler Hotel and numerous insurance company buildings.

Areas of architectural interest are primarily on the periphery of the square. Piano Row, designated as historically significant at the federal, state, and local levels, extends from Park Square to Avery Street along Boylston and Tremont Streets. These nineteenth-century row houses originally contained the showrooms of Boston's important piano companies and music publishing industries, and today are occupied by office and retail users. Recent projects--such as the State Transportation Building, the Four Seasons Hotel and Condominiums, the planned redevelopment of the Arlington Street/ Hadassah Way parcel, and the rehabilitation of other commercial buildings--have helped to offset the deterioration suffered by Park Square proper over the years.

Future Development in the Area

The analysis year for the 500 Boylston Street Project Final EIR is 1989, the time at which the project will

be substantially completed and occupied. For the purpose of environmental analyses, certain assumptions have been made as to changes in the surrounding area that would affect the base case for 1989.

The assumed 1989 development setting includes the completion of the following:

- o Back Bay Station
- o John Hancock Clarendon Building renovation
- o 399 Boylston Street
- o State Transportation Building
- o Arlington Street/Hadassah Way parcel redevelopment
- o Four Seasons Hotel and Condominiums
- o One Exeter Place
- o Copley Place
- o Copley Square reconstruction
- o Hynes Auditorium expansion.

PERMITS

In conjunction with the preparation of this Final EIR, the proponent will expect to comply with the following State agency review, permit, or approval processes for the project:

- o Massachusetts Department of Environmental Quality Engineering, Sewer Connection and Extension Permit (MGL Ch. 21, S. 43); Fossil Fuel Utilization Permit (MGL Ch. 111, S. 142 A-E); New Sources of Air Contaminants Review.

- o Massachusetts Executive Office of Environmental Affairs, MEPA Certification (MGL Ch. 30, S. 61, 62-62H).

- o Massachusetts Historical Commission, Determination of Effect to Historic Properties.

- o Metropolitan District Commission or successor agency or authority, Industrial User Discharge Permit (MGL Ch. 92, S. 1-8A).

In addition, municipal operating permits, including zoning approval, will be secured for this project effort.

III Description of Alternatives

Program uses and general design objectives for 500 Boylston Street have evolved over two years of planning by the BRA, the CAC, and the proponent. In 1982, specific program and design guidelines were prepared by the BRA on behalf of the City as a Request for Proposals for redevelopment of the St. James Avenue Garage site. The BRA selected the proposal submitted by the joint venture of New England Mutual Life Insurance Company and Gerald D. Hines Interests, Inc.

The Environmental Notification Form (ENF) for this project was filed with the Executive Office of Environmental Affairs (EOEA) on May 31, 1984. The Certificate of the Secretary of Environmental Affairs on the ENF, July 6, 1984, required a State EIR focusing on potential impacts of a sewer connection for which a state permit is being sought. In addition, the proponent has prepared this Final EIR, consistent with MGL Ch. 30, S. 62-62H, for submission to the BRA as required in the Authority's Terms and Conditions for Developer Designation of December 8, 1983. The two alternatives and environmental issues that were analyzed in the Draft EIR, and elaborated upon further in this Final EIR, for the redevelopment of the block bounded by St. James Avenue and Clarendon, Boylston, and Berkeley Streets were based on the broadly based scope for the BRA Draft EIR (see Appendix 1).

The BRA and CAC are continuing to work with the proponent to review program and design refinements that meet shared goals while being sensitive to the project's proposed schedule. The program and design assumptions used in this Final EIR are based on the most current project information.

ALTERNATIVE 1: NO-BUILD

The no-build alternative assumes the continuation of the present uses of the project site, with no major reconstruction of the garage or significant improvement to the existing structures and streetscape. New England Mutual Life Insurance Company owns all the buildings that front on Boylston Street on the block. Each of these buildings supports mixed office and retail uses, excepting Louis and Eddie Bauer which are sole tenants in their respective buildings. The IBM Corporation moved out of its location at 520 Boylston Street in December 1984 and the building is now vacant. Retail

uses and lobby entrances typically occupy the ground-level story of these structures, with office space occupying the upper floors. It is likely that these types of uses will continue under this alternative.

The buildings represent a variety of architectural styles. All but the Colton Building, the Elkins Building, and original Louis Building were built between 1947 and 1965 and are of similar scale and massing, with uniform setbacks and relatively flat facades. The Colton Building was constructed in 1882, gutted by fire, and substantially renovated in the early 1900s.

The St. James Avenue Garage, owned and operated by the City of Boston, provides 625 public parking spaces. While the City has stated in their Development and Design Guidelines for the St. James Avenue Garage Parcel that "the City intends to sell this parcel," it is assumed under the no-build alternative that the garage would continue to provide public parking.

The costs of this option include the loss of revenues to the City, which more intensive site use would generate, and the opportunity for visual enhancement of the St. James Avenue Garage parcel. The garage itself is badly in need of repair. An evaluation by consulting engineers to the proponent indicates the garage would have to be closed to undertake the necessary rehabilitation, which would result in a temporary loss of both the parking spaces and fees.

ALTERNATIVE 2: 500 BOYLSTON STREET PROJECT

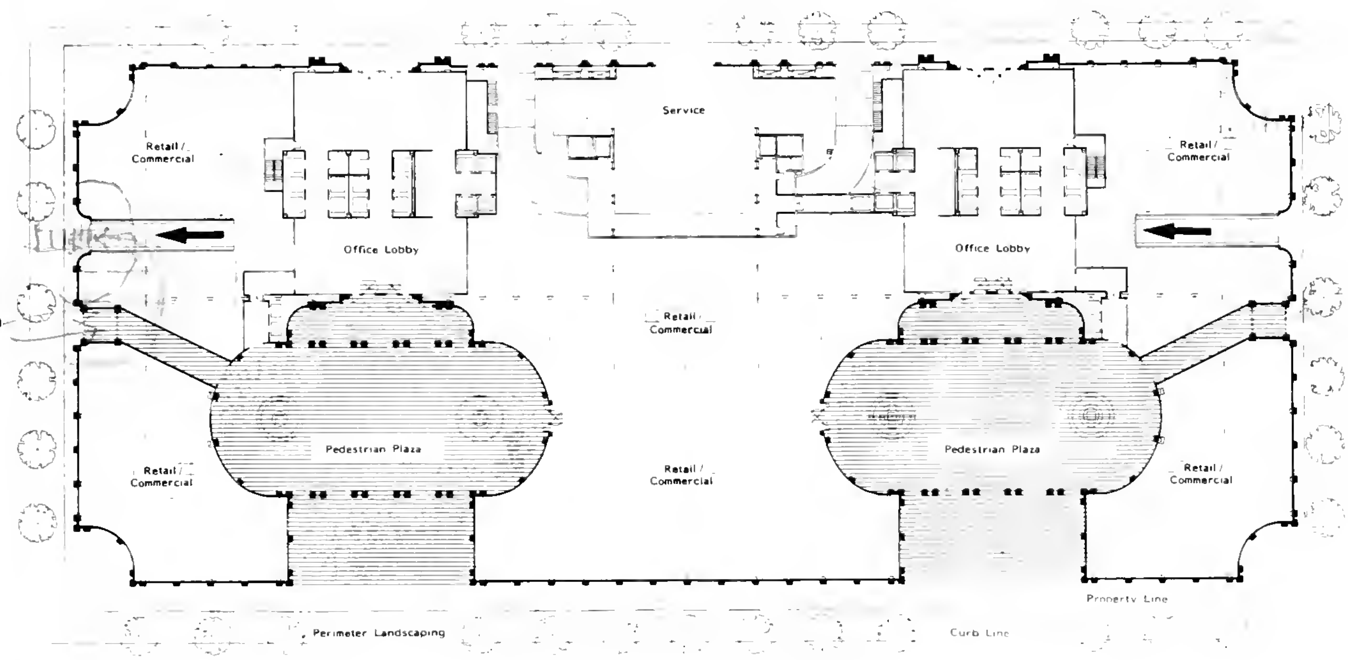
This development project, proposed by the proponent, will establish an active, mixed-use development consisting of offices, retail stores, restaurants, other commercial uses, pedestrian plazas and walkways, and a below-grade parking garage (see Exhibit III-1). Located in Boston's Back Bay, the 3.15-acre parcel on which the proposed project will be sited is bordered by St. James Avenue and Clarendon, Boylston, and Berkeley Streets.

The 1.2 million square feet of office space will be primarily located in two towers, rising 19 stories above a 6-story base structure, resulting in a maximum project height of 25 stories. The towers will be

EXHIBIT III-1

Revised Ground Floor Plan

St. James Avenue



Berkeley Street

Clarendon Street

Boylston Street

A New England Life/ Gerald Hines Project
John Burgee Architects with Philip Johnson

situated on the southern portion of the site along St. James Avenue. Office uses will also be located in the upper floors of the six-story base. Approximately 100,000 square feet of retail/commercial use will be contained in the first two levels of the six-story base structure. Approximately 1,000 on-site parking spaces will be provided below grade, of which 625 spaces will be designated for public use. Service and parking entrance and egress to the site will be from St. James Avenue and Berkeley and Clarendon Streets.

Pedestrian open areas will include the sidewalks around the site and two plazas opening on to Boylston Street. Since submission of the BRA Draft EIR the plans for the sidewalk along Berkeley Street have been widened by four feet to a width of 19-1/2 feet. The plazas will be lined with active retail uses and will provide open entries to the office tower lobbies.

The approximate distribution of square feet by use is as follows:

o Office	1,200,000 SF
o Retail/Commercial	100,000 SF
o Pedestrian Open Space	55,000 SF

The other major site use is the 1,000 space below-grade parking garage.

IV Environmental Issues

INTRODUCTION

Pursuant to the scope for the environmental assessment of the proposed project (see Appendix 1, Attachment 2), the following issues were examined in connection with the no-build and 500 Boylston Street Project alternatives for the site bounded by St. James Avenue, and Clarendon, Boylston, and Berkeley Streets: Transportation, Air Quality, Natural Resources, Archaeology, Historic/ Visual Quality, Wind, and Shadow. The results of the analyses were presented in the Draft EIR, which was submitted to the BRA in October 1984. Following the public review period, the BRA prepared written comments for the proponent requesting clarification, elaboration, and some further analysis of the environmental issues covered in the Draft EIR. This chapter presents detailed responses to the BRA's comments on the following environmental issues:

- Transportation
- Air Quality
- Natural Resources
- Historic/Visual Quality
- Wind
- Shadow

In addition a brief status report on the archaeological reconnaissance studies currently underway on the site is included.

Comments

The BRA's cover letter and comments are reproduced on the following beige pages, along with the letters submitted to the Authority by concerned parties during the public review period. Each of the comments in the BRA's list, which follows the director's cover letter, is numbered, and then reprinted and responded to in the appropriate section of this chapter.

Boston Redevelopment Authority

KENNETH S. MOZZLESKI

DEC 10 1984

Gerald D. Hines Interests

Stephen F. Coyle/Director

November 29, 1984

Mr. Joseph O'Connor
Copley Real Estate Advisors
535 Boylston Street
Boston, MA 02116

Dear Mr. O'Connor:

As part of the Boston Redevelopment Authority's review of the 500 Boylston Street development proposal, the Authority has reviewed the Draft Environmental Impact Report which you have submitted to us pursuant to our environmental review requirements for major development projects.

As the BRA is acting with respect to the project only in its municipal planning board capacity and not as a state redevelopment authority under Chapters 121A and 121B of the General Laws, the actions of the BRA are not subject to the Massachusetts Environmental Protection Act, G.L. c. 30, SS *et seq*. Nevertheless, the BRA has required the developer to prepare a report analyzing all environmental impacts of the Project. The scope of the environmental report was set forth in a May 1984 letter from the Authority.

An environmental report was submitted by New England Life/Hines Interests on October 12, 1984. On October 13, 1984 the BRA published notice in the *Boston Herald* of the availability of the report and the opportunity to submit written comments.

Since the tentative designation of the developer on December 8, 1983, the development team and the BRA have been evaluating design measures that would mitigate possible adverse impacts, particularly in the areas of traffic, shadow, wind, and geotechnical issues.

1 City Hall Square
Boston, Massachusetts 02201
(617) 722-4300

The Authority herein affirms that the Environmental Impact Report for the above referenced project, dated October 1984, does comply with the scope of impacts described in the Director's letter of May 1984, and is prepared in accordance with the procedures of the Authority and other requirements concerning the protection of the environment applicable to the project. The Report also has been made available to other public agencies, including the MEPA office, and to interested individuals and groups which have requested copies. A copy of the Authority comments are attached for your attention. In addition, copies of letters the BRA has received from other entities are attached for your information. Following this letter, you should submit to the BRA a final EIR which responds to the BRA comments. In preparing your responses, you should work with appropriate Authority staff.

Following the submission of the final EIR, the BRA Board will vote on your application for a Planned Development Area designation.

Sincerely,
BOSTON REDEVELOPMENT AUTHORITY

Stephen Coyle
Director

In general, the Draft EIR presents a comprehensive evaluation of the impacts of the project. However, there are a number of questions, particularly in the transportation and air quality sections. Areas in which there are some questions regarding the analysis or the information presented, or a need for clarification, are discussed below in detail.

Transportation

General: The major traffic problems perceived by the Back Bay community is the additional traffic imposed on Berkeley Street, which is considered to be a neighborhood residential street. Berkeley Street, however, represents the major access to Storrow Drive, both east and west, and to Beacon Street outbound. Berkeley Street also has been identified on the Draft EIR (as well as in the EIRs of other Back Bay projects) as a seriously congested street in the evening peak period, particularly at Beacon Street. The Draft EIR also estimates the 500 Boylston contribution to the 1989 P.M. peak traffic on Berkeley Street at Beacon to be around 7%, so that this project is hardly the sole culprit. Nonetheless, as each new project is added, the already serious situation is further exacerbated. Therefore, it is critical that satisfactory mitigation measures be adopted to reduce substantially the number of cars using Berkeley Street between Newbury Street and Storrow Drive. Although a number of measures are suggested in the Draft EIR, others warrant investigation. **1**

In addition, the traffic study should be amended to include the impact of the proposed 700 car parking facility on the Tent City site. **2**

pp. 33-34 (Figs. IV-5, 6 (also Figs. IV-11, 12, 13, 14)) There is a considerable discrepancy in flow volumes between adjacent intersections so that the flows do not balance out. Why does this occur, especially when there are no major generators (e.g. parking facility) between the intersections which could account for a difference? **3**

Moreover, in comparing the traffic volumes in Figures IV-5, 6 (existing peak hour volumes) with the peak hour turning movement counts presented in Appendix 2, there are several noticeable discrepancies and in some cases the differences in volumes are quite significant (e.g. over 200 vehicles). This should be explained. **4**

p. 36 (Fig. IV-7) The basis for the parking supply numbers should be specified. In some cases they differ from the numbers shown on the City's parking facility map (see Fig. 6.2-1 of the Hynes Auditorium EIR). **5**

p. 48 Tables IV-7, 8) The City's report "Parking in Central Boston" indicated for the Back Bay a model split (% auto) of 40-45% for work trips and 48-52% for non-work trips. While it is recognized that the office split is based on actual surveys of existing insurance companies, might not the retail trips be somewhat underestimated, being 30% and 40% respectively? The same report also assumed a vehicle occupancy rate of 1.51 for work trips and 1.31 for non-work trips (vs. 1.4 and 1.9 for the retail). Again, non-work vehicle trips may be underestimated. **6**

p. 51 (Table IV-12) The peak hour trip generation data make no allowance for A.M. peak hour employee vehicle departure or P.M. peak hour employee vehicle arrival. Support for this assumption should be provided or the tables revised. Do the "all vehicle" figures include employee drop-off, taxi arrivals/departures, and deliveries? **7**

p. 54 In the discussion of future base traffic, it does not appear that an annual growth in regional traffic, independent of traffic generated by new developments in the Back Bay, has been taken into account. If this information is available it should be analyzed. **8**

p. 59, 61 (Figs. IV-11, 13) The 16% of the project-generated (and presumably other new development) traffic coming from the north and northeast presumably comes down Storrow Drive to the Arlington Street off-ramp to Beacon Street. However, the volume increases on Beacon Street (1989 No-Build vs. 1984, 1989 Build vs. No-Build) do not reflect this, showing lesser increases. This should be explained or appropriate corrections made. **9**

p. 62 (Fig. IV-14) Why is there less traffic on Boylston Street, going straight, in front of the project site under build condition than under the no-build condition? **10**

pp. 63ff There is a question as to whether the vehicular capacity calculations tend to overestimate the level of service which as an intersection might create. The following points on methodology should be noted:

11

- Where pedestrian activity is high and exclusive pedestrian signal phase is in use or indicated, the capacity calculations simply use the capacity per hour of green table with an additional phase. This does not compensate in any significant way for an exclusive pedestrian phase. Many of the intersections in the study area (e.g., Boylston and Arlington) are affected in this way.

- On multilane approaches for the same movement, there is no allowance for unequal distribution of cars between the lanes, thereby, presuming an efficiency that is not there. The analysis should clarify this. **12**

p. 65 A Level of Service of "F", where the V/C ratio exceeds 1.00, should be included on Table IV-22 and in the discussion. Stuart at Arlington falls into this category in the P.M. peak hour, representing a degradation from the existing condition. **13**

p. 71 Dealing with the future parking supply and demand for short term parkers, we see that 835 vehicle arrivals per day (pg. 52) demand 140 short-term spaces (pg. 71). This implies a turnover rate of about 6 per day, which seems excessive. The short-term demand is probably underestimated and should be reexamined in the Final Report. **14**

p. 72 The analysis makes strong assumptions on the expansion of the National Garage by 300 spaces for employee parking. Although New England Life is pursuing this matter at present, there is no assurance that this will occur. Without it, the estimated parking shortfall would by 675 spaces, this on top of a projected Back Bay shortfall of 1700 public off-street spaces by 1985. The Final EIR should indicate a resolution of this potential problem should the National Garage not become available. **15**

p. 72 There is some confusion between the definition of types of parking which exist now and which are proposed for the future. Today, the St. James Garage has about 625 spaces which are mainly open to the general public for a fee on a daily basis. Around 75 spaces are kept open in the morning until after the peak hour so that this number might be available for non-commuters, assumedly short-term parkers. There is not (officially) a larger number of spaces leased on a monthly basis. The point is that the existing garage is open to the public on a daily basis. **16**

p. 75 (Table IV-27) Intersection Analysis With and Without National Garage Expansion, does not include the intersection at Dartmouth Street and Columbus Avenue. Although footnote #1 explains that only intersections experiencing a difference in activity are shown in the table, it is difficult to understand why the intersection closest to the National Garage would not register increased traffic. **17**

p. 78 (Table IV-30) Why is there a difference in the P.M. peak hour ridership estimates between the two EIRs, which account for the same new areawide development? Also, Orange Line southbound 1983 and base condition ridership figures are different (6,700 vs. 6,500 and 10,300 vs. 10,100, 500 Boylston and Hynes respectively). Why? (Similarly, in Table IV-28, total new transit trips is given as 29,000, whereas the same table in the Hynes EIR gave 30,100. What accounts for the difference?) **18**

p. 80 The noontime pedestrian volume from the project appears to be underestimated, especially considering that the project will provide some 1400 jobs and a considerable number of these employees can be expected to leave the building during the noon hour. **19**

p. 82ff Among the mitigation measures to which the developer should be considered are the following: **20**

(1) Subsidization of employee costs for public transit to the same extent that employee parking is subsidized.

(2) Implementation of the MBTA Pass Program through payroll deduction, or as an employee benefit (see (1) above) to make public transportation more attractive.

(3) Institution of a variable work hours program, to alleviate rush hour congestion (and improve air quality at the same time).

These should be discussed in the Final EIR.

p. 91 — The impact (e.g. change in V/C ratios, LOS) of diverting flows onto alternate routes should be assessed. **21**

pp. 94 — Retiming of the Back Bay's traffic signal system may have beneficial impacts, but there is as yet no City commitment to proceed with this (similarly with the proposed intersection-related measures). The assumption that allocating more green time for Berkeley at the expense of Beacon would be beneficial may be questionable, since Beacon Street also backs up during the rush hour. **22**

p. 96 — The conclusion that most or all of the parking shortfall will shift to public transportation may not be entirely realistic. The excess capacity of the Green and Orange lines is useful only if one lives in an area served by these lines, but there is no guarantee that all of the shortfall would live in such areas. Therefore, the assumption in shift of modes is highly optimistic. **23**

Fig.IV-6 IV-12, IV-14 — On traffic volumes, it appears that the peak hour volumes on Clarendon Street south of Stuart Street and south of Columbus Avenue may be exaggerated, seeing that they are higher than north of Stuart and the Mass. Turnpike ramp is a traffic bleeder. This should be reviewed since it is of such importance to the South End community. **24**

Traffic Network Maps — The traffic network maps are misleading in showing Columbus Avenue linking with Charles and Boylston. This should be corrected. **25**

The Final EIR should discuss the consistency of this project with the management of the Boston Parking Freeze. **26**

If off-street parking is removed from Arlington Street as a mitigation measure, what assumptions have been made regarding how that demand will be met? **27***

Do the results from the receptors modeled in Tables IV-37 and IV-38 include impacts from the adjacent intersections that were also modeled? **28***

* Comments 27 and 28 refer to issues raised in the Air Quality section (pp. 103-119) of the BRA Draft EIR and, therefore, are responded to in the Air Quality section of this BRA Final EIR.

Appendix 2 - Transportation

Why are different time periods used for the A.M. and P.M. peak hour counts, rather than all being the same (e.g. 8-9 A.M., rather than some 8-9, some 8:30-9:30, etc.)? **29**

The Beacon/Charles and Beacon/Arlington intersection analyses do not seem to include a pedestrian phase. This may be true at other intersections as well. Since this is an important impact in both LOS and the air quality analyses, the omission is questionable. **30**

Air Quality

p. 111 (Table IV-35) The air quality analysis indicates an 8-hour violation (1989 Build) at the Berkeley/Columbus intersection, but the Intersection LOS analysis (Table IV-24) predicts a LOS of A at the same intersection. This would appear to be contradictory. Are the contributions from the Turnpike included? An explanation should be provided in the Final EIR. **31**

Also, the intersection of Clarendon and Tremont is covered in the air quality analysis but not in the traffic analysis. In view of the strong community interest of this location it should be added to the traffic analysis section of the Final EIR. **32***

pp. 112, 118-9 What is the commitment to the mitigation measures outlined to reduce CO levels. **33**

p. 117 (Asbestos) EPA regulations regarding asbestos removal also must be met and should be referenced here. **34**

(Construction Impacts) The dust emission factor does not account for building demolition impacts; this also should be evaluated. **35**

p. 118 Since the Inspection and Maintenance Program is in operation, it cannot be included as a mitigation measure to reduce CO emissions. **36**

Appendix 3 - Air Quality

The traffic ratios in Figure 1 do not appear to be supported by the data presented in the Transportation Appendix. Also, the 8-hour results (Table IV-35 of the EIR) appear to be rather low compared to the 1-hour results. All appear to be below the urban persistence factor (ratio of eight-hour to one-hour CO concentration) of 0.6 to 0.7, which is the general guidance of the EPA. This discrepancy should be investigated and thoroughly discussed, and any necessary changes made. **37**

In addition, the V/C ratios used in this air quality study (demand volume on line 2 of Worksheet 2 divided by the capacity on line 6.7, and the results summed) and in the traffic study do not appear to coincide in all cases, even approximately. (As an **38**

* Comment 32 refers to an issue applicable to the traffic analysis and, therefore, is responded to briefly under the Air Quality Section of this Final EIR and in greater detail in the

example for 1989 Build case, Clarendon and Boylston, the air quality V/C is 1.28 whereas the traffic V/C is 0.67.) There should be consistency between both studies, especially since the traffic analysis includes the effect of pedestrians on intersection operations, an effect not explicitly accounted for in Worksheet 2. This discrepancy should be discussed and any necessary revisions made.

Natural Resources

pp. 143-4 What is the basis for the minimal ground settlement conclusion? There apparently was a substantial settlement of part of Boylston Street during construction of the Four-Seasons Hotel. Also, on page 144 it is stated that the maximum settlement around the John Hancock construction was 1.5 feet. However, an earlier Haley and Aldrich report presented to the BRA indicated a settlement of up to 3 feet in surrounding streets, twice the amount reported in the EIR. This should be clarified. **39**

p. 149-151 The construction monitoring systems and other mitigation measures need to be specified in greater detail in the final report. For example, the early warning capability needs to be described. There is considerable concern over the potential subsidence which could occur at Trinity Church, the Berkeley Building, and the St. James sewer, and assurances are needed that appropriate mitigation measures will be followed to reduce potential subsidence to acceptable levels. **40**

p. 150 The MBTA should be consulted regarding potential impact on the Boylston Street subway tunnel. **41**

If additional connections are made to the St. James Avenue sewer, the impact on the watertable in the vicinity of St. James Avenue should be discussed. In addition, the impact of projected subsidence of soil under St. James Avenue on possible additional sewer connection openings should also be considered. **42** **43**

Historic/Visual Quality

p. 162 ff More explanation is needed as to how the two towers relate to the historic scale and character of the Back Bay. **44**

Wind

p. 186 Previous wind studies did not show a net reduction in pedestrian level winds. Rather, of the 327 station conditions tested, 74 showed higher winds with the project than existing conditions, some of the increases being considered significant. **45**

pp. 195-7 While generally winds are either increased or decreased about 50/50 around the complex, winds are generally exacerbated around Trinity Church, the John Hancock Tower, along Clarendon Street, and to the east of the project. Also, some seasonal increases are not reflected in the annual statistics. **46** **47**

Of the 32 stations compared, winds increased at 12 stations (or 38%), some by as much as 5.9 mph. Therefore, it is somewhat misleading to conclude that on the average winds will be reduced or remain unchanged. At station 48 (corner Clarendon and Boylston) the project causes existing acceptable conditions to become unacceptable, and at stations 12, 59, 62, 66, 73 and 80 existing unacceptable conditions will be further exacerbated, by various degrees, by the project. **48**

p. 197 Mitigation measures have been suggested, but were not tested as required by the BRA scope. Since, as noted above, some adverse, or more adverse, conditions are created by the project, the mitigation measures should be tested and the results included in the Final EIR. The intersection of Clarendon Street and St. James Avenue is particularly critical in this regard. **49**

(Scope)

Air flow modifications resulting from the project should be considered. Especially important in this regard is the potential for a channeling effect on St. James Street and its impacts on wind conditions and air quality (increasing dispersion or creating a canyon effect). **50**

Appendix 6 - Wind

p. 17 The photograph of the model does not appear to include the 399 Boylston Street building. Why was this building not included? This building should be added for any retesting done. **51**

pp. 8-9 The wind consultants make an assumption that the BRA guideline criteria for acceptability of wind is the dividing line between acceptable and uncomfortable for walking and thus is less restrictive than Melbourne's criteria. However, the BRA criterion of Ueg = 31 mph is a limit for acceptability and thus is equivalent to the dividing line between Melbourne's categories 1 and 2. The result is that the BRA criterion is really more restrictive than Melbourne's, used by the MIT wind tunnel. This difference should be resolved in any future studies. **52**

pp. 33,35 (Tables 1,3) Why are some of the wind velocities different for the same station? For example: **53**

Station 1 (proposed) - effective gust = 18.8 (Table 1)
= 18.1 (Table 3)

There are several other examples. Which are the correct numbers?

pp. 39 ff On several pages of the discussion, symbols and formulae are missing. **54**

p. 44 Why were surface wind data from Logan, rather than winds aloft data, used? Would not the winds aloft data be more reliable since they would be unaffected by surface features (such as tall buildings which are added over time). Winds aloft data are available and have been used in other wind studies in Boston. **55**

p. 49 Figure numbers are incorrect; should refer to 12 a, b, c, not 11a, b, c, etc. 56

p. 116 Why are the Weibull constants for Boston used for this study different from those used in the Rowes Wharf wind study, also done by MIT (see page 165 of Rowes Wharf Final EIR, Appendix 5)? 57

Shadow

Fig. IV-34, 35, 36 The shadow diagrams, while very useful in distinguishing shadows cast by the project from those cast by existing buildings lack a distinction in the overlapping situation, i.e., one cannot readily distinguish where the project shadow is a new shadow and where it overlaps an existing shadow. 58

In addition, the shadow diagrams are inaccurate, particularly as they relate to the Clarendon Street Playground and the Commonwealth Avenue Mall, since apparently the correct time for Boston within the time zone was not used. Adjustments should be made in the Final EIR and accurate studies presented. 59

Miscellaneous Corrections/Comments

p. 12 The Back Bay was filled in the 1850's, not the 1880's. 60*

p. 30 (Table IV-3) Boylston Street P.M. peak volume should be 1150, not 1160 (see Fig. IV-6). 61*

p. 31 (Fig. IV-3) The arrow on Marlborough Street (between Arlington and Berkeley) should be reversed (the street is one-way west-bound for this block). 62*

p. 36 (Fig. IV-7) The Copley Place parking numbers are not correct. There are 275 spaces at the Weston Hotel (not 1157 as shown) and 860 in the Copley Place parking garage across Stuart Street. 63*

p. 41 (Table IV-3) Indicate the date of these statistics. 64*

p. 155 (Fig. IV-29) The Back Bay and South End historic districts boundaries should be added to the figure (also stated in the text on pg. 154). 65*

* Miscellaneous comments 60 through 65 are responded to under the appropriate chapter of this Final EIR. Comment 60 has been noted and corrected in Chapter II, Comments 61 - 64 are responded to at the end of the Transportation section of Chapter IV, and Comment 65 is under the Historic/Visual Quality section.

November 13, 1984

RESOLUTION OF THE

ST. JAMES AVENUE GARAGE CIVIC ADVISORY COMMITTEE

THE FOLLOWING STATEMENT WAS MOVED, SECONDED, AND APPROVED UNANIMOUSLY AT THE NOVEMBER 12, 1984 MEETING OF THE ST. JAMES AVENUE GARAGE CIVIC ADVISORY COMMITTEE:

The CAC recommends to the BRA director that the following additions and modifications be included in the Final Environmental Impact Report for the 500 Boylston Street Project:

a. Satisfactory mitigating measures be adopted by appropriate agencies to substantially reduce the number of cars using Berkeley Street between Newbury Street and Storrow Drive. Of paramount importance is the restoration of the northerly Traffic flow of Charles Street between Beacon and Cambridge Streets.

b. The traffic study be amended to include the impact of the proposed 700 space parking facility on the Tent City Site.

c. Further wind analysis regarding all points made worse by the proposed project, especially the intersection of Clarendon Street and St. James Avenue, including mitigating measures to correct such conditions.

d. A new shadow study which accurately depicts predicted conditions, especially as it relates to the Clarendon Street Playground and the Commonwealth Avenue Mall.

e. A binding assurance that substructure and St. James Avenue sewer issues will be addressed in considerably more detail, and the understanding that the acceptable subsidence will be less than suggested in the Draft EIR. The Committee requests that full agreement be reached prior to any demolition or construction permits being issued.

Because the responses to these issues may affect the recommendation of the Committee regarding approval of the 500 Boylston Street PDA application before the BRA Board, the Committee hereby requests that the Board delay its final vote on the application until the Committee has received and commented on the Final EIR.

Respectfully Submitted,

Spencer M. Rice

The Commonwealth of Massachusetts
Department of Environmental Quality Engineering
Metropolitan Boston - Northeast Region
323 New Boston Street, Woburn, MA 01801

ANTHONY D. CORTESE, Sc.D.
Commissioner
727-5194

RECEIVED
NOV 14 1984
BOSTON REDEVELOPMENT AUTHORITY
OFFICE OF THE DIRECTOR

November 13, 1984

841114-014

Stephen Coyle
Director
Boston Redevelopment Authority
One City Hall Plaza
Boston, MA 02201

RE: EOEA #5217-500 Boylston Street; Review of Draft Environmental Impact Report.

Dear Mr. Coyle:

The Department of Environmental Quality Engineering has reviewed the Draft Environmental Impact Report (DEIR) submitted to the Boston Redevelopment Authority for the 500 Boylston Street Project. Based upon a review of this document by staff fromn the Division of Air Quality Control, this office wishes to make the following comments.

1. According to the Draft, the project will require 1000 parking spaces upon completion. This demand will be met by increasing the capacity of the existing St. James Avenue Garage by 375 spaces, as well as adding 300 spaces to the National Garage on Dartmouth Street. Will this increase in parking supply result in an even greater increase in demand from users of outlying parking lots, thus resulting in an increase in trips to the area? The assumption in the Draft appears to be that all new demand will be the direct result of this project. In addition,since the National Garage proposal is being submitted as a seperate development project there is the potential that it will not be built. This factor should be considered in the Final EIR.

2. The DEIR states that 2/3 of the newly created parking demand will choose the 500 Boylston Street garage. If this is correct then what assumptions have been made regarding the current users of the St. James Garage? Is it correct to assume that since 2/3 of the new demand equals 375 vehicles which is the number of tenant spaces that will be available, this demand will include only tenant parking? If not then the Final should discuss the possible displacement of current users of the St. James Garage.

3. According to the DEIR (Page 50), the 1989 modal split "represents a 'worst case' traffic analysis since it implies that all who want to drive to the project site will have a parking space available." We would suggest that a worst case would exist when demand exceedes supply at the site resulting in an additional deficit in the number of parking spaces. This would resulti in an even greater number of vehicles using the local streets searching for parking.

4. The proponent should discuss any plans for implementing a preferred parking program for car and vanpools using the tenant parking spaces in the 500 Boylston St. garage.

5. The Final should discuss the status of any applications for permits that are pending or proposed regarding the use of spaces subject to the Boston Parking Freeze (40 CFR 52.1135). In addition the consistency of this project to the management of the Freeze should be discussed.

6. Are the trip generation rates used in this project sufficient for this type of development? The Copley Place project included a greater amount of retail space as well as hotel and restaurant use. Is it a conservative estimate compared to ITE data, and how does it compare with data used in similar projects? Does the total number of trips include truck traffic?

7. Have any commitments been made by the appropriate City or State agencies to implement the mitigating measures used in the air quality analysis? This is particularly important due to the levels projected to occur in either the build or no-build case. Furthermore, the potential for violations of the eight hour NAAQS for carbon monoxide remains high even with mitigation in place. Have any other more effective alternatives been considered?

8. If on-street parking is removed from Arlington Street as a mitigation measure, what assumptions have been made regarding how that demand will be met.

9. Do the results for the receptors modeled in Tables IV-37 and IV-38 include impacts from the adjacent intersections that were also modeled?

10. Should changes in traffic data be requirred for the Final, then the air quality analysis must reflect those changes.

Thank you for the opportunity to comment on this DEIR. Please contact Barry Porter of the Department's Division of Air Quality Control's

Boston office (292-5598) should you have any questions.

Very Truly Yours,

Barry L. Patten

for Michael J. Maher, Chief
Air Quality Control Section

cc: Steve Davis, MEPA
Rebecca Packard, SOM
Peter Gouldberg, Tech Environmental
Geoffry Boehm, Boston Air Pollution Control Commission

BROMBERG SUNSTEIN & McGREGOR
ATTORNEYS AT LAW
[illegible] STREET SUITE [illegible]
BOSTON 02109

[illegible] SUNSTEIN
[illegible] CARL BROMBERG
[illegible] McGREGOR
FREDERICK V. CASSELMAN
[illegible] FALKOFF
[illegible] JOHNSON
[illegible] NAITOVE
[illegible]
[illegible] BUFFERD
OF COUNSEL

[illegible] 426 9464
TELEX [illegible]
CABLE APOLLO BOSTON

November 21, 1984

Stephen Coyle, Director
Boston Redevelopment Authority
Boston City Hall, 9th Floor
Boston, Massachusetts 02201

Re: 500 Boylston Street Project
Comments on Draft Environmental Impact Report

Dear Mr. Coyle:

The Neighborhood Association of the Back Bay (NABB) and Trinity Church submit the following comments with respect to the above Draft Environmental Impact Report (DEIR). These comments supplement the comments made by the St. James Avenue Garage Civic Advisory Committee.

As a condition of approval of the Planned Development Area requested by the developers, the BRA must find that "nothing" in the plan will be "injurious" to the neighborhood. The environmental studies ordered by the BRA and the state MEPA office are intended to be helpful to the BRA in making that determination. NABB and Trinity believe that certain of the issues noted herein are sufficiently serious that the BRA should withhold approval of the Planned Development Area until such time as these issues are resolved.

We have not undertaken an exhaustive review of the data or methodology of the developer in preparing the DEIR, and are relying on the BRA and its staff for this review. Except as specifically indicated, these comments are based on the stated conclusions of the DEIR.

1. Transportation.

(a) Traffic. The DEIR indicates that traffic will be worse upon completion of the project than did the earlier study done in June, 1983. Many intersections show substantially higher traffic counts, and correspondingly higher level of service ratings. We are particularly concerned about the traffic levels on the completely residential streets located between Newbury Street and Beacon Street. Berkeley Street in particular is projected to have P.M. peak hour traffic levels higher than those of probably

any other residential street in the city. The mitigation measures proposed in the DEIR are directed to how to speed the traffic flow, rather than how to reduce it. This is an unacceptable emphasis for a residential area and would further reduce pedestrian safety and residential character.

If the project is to go forward, the city must make a decision on how to deal with the larger traffic issues. The reversal of Charles Street has had a severe effect on Berkeley Street, and return to its prior direction of flow should be implemented. There may be other traffic redirections as well which should be implemented as part of a general effort to detour traffic from residential streets. If neither of these alternatives can be inplemented, then the size of the project should be reduced. While the project is only a contributing factor to a problem which is already out of control, the BRA should not approve a PDA which exacerbates the problem.

(b) Parking. The DEIR assumes the addition of 300 spaces at the National Garage, an action which has yet to be approved and faces some strong opposition from adjacent neighborhoods. What will be the impact if these spaces are not available? Where do people (commuters or shoppers) park when there are no legal spaces available? If the garage is not built, sufficient safeguards to maintain residential and retail parking should be established. The DEIR fails to account for the projected traffic and parking impacts of Tent City; the final EIR should address these issues as well.

2. **Natural Resources.**

(a) Substructure. We are not satisfied that the criteria for ground movement around the edges of the site are adequately stringent. In particular, there is concern for Trinity Church on Clarendon Street and also the Decorators Building at Berkeley Street. Furthermore, the Back Bay Water Table Study is not completed. These problems are of a technical nature, however, and do appear to have reliable solutions. As a result, their resolution need not hold up the Zoning approval, but must be resolved only before any building or demolition permits are issued. At this time we only seek the reaffirmation of the Developers that they and their consultants will take every feasible step to assure that the construction of the building substructure will not cause any subsidence which will affect surrounding structures.

We note, however, one change in the proposed conditions between the Draft EIR and the preliminary studies carried out

last year -- the depth of the excavation was originally not to exceed 36 feet; the current maximum depth is now proposed as 40 feet. We sincerely hope that the Developer can live within the originally proposed restriction of 36 feet, at least within a 50 foot horizontal distance from Berkeley and Clarendon Street.

(b) St. James Avenue Sewer. Little or no additional information was forthcoming on the potential problems that may occur as a result of the construction affecting the St. James Avenue storm and sanitary sewers, and consequential effects of its being disturbed by subsidence. A few of the questions left unanswered are:

- Is it likely that the "chimney" connections to the sewer lines were and could be again responsible for lowering the water tables in the vicinity of St. James Avenue?

- Should a permanent solution be adopted to assure that these sewer lines will not cause lowering of water tables?

- What do the city records show with respect to active and abandoned connections to these sewers in the vicinity of the 500 Boylston Street Project?

- When will the long-promised inspection of the condition of the sewers be conducted, and when will the results be available?

- How much opening of connections to the sewers can be predicted on a "worst case" basis as a result of the projected subsidence of the soil under St. James Avenue?

3. **Wind.** NABB is concerned that, while it appears that the project reduces wind at many locations, it worsens the majority of sites identified by the developer as currently exceeding BRA guidelines. The improvements in wind conditions promised by the wind erosion study do not seem to be borne out by the hot-wire test. One location of particular concern is the northwest corner of Clarendon Street and St. James Avenue.

Mitigation measures have not been adequately explored. There is no explanation as to whether the less favorable results which the hot-wire test produced were due to a change in methodology or a change in the shape of the building. Alternative massings should be tested to determine which elements of the project are causing the problems.

4. Shadows. We have reviewed the shadow boards included in the DEIR for 9:00, 12:00, and 3:00 on the solstices and the equinoxes. In addition, we have reviewed boards detailing the shadows cast on the Playground in the early morning during late October through mid-February. Comparison of the Playground boards with actual conditions demonstrates that the boards are in serious error. Existing shadows shown on the boards to be in the Playground are not even on the same block. A possible explanation is that the shadow studies are simply wrong by 25 minutes, an error severe enough to render suspect the "snapshot" boards of the DEIR. Thus, as a general matter, the slight incremental shadow which the boards show for the Back Bay is wrong and must be re-figured. In particular, from our direct observations, it appears that the building will cast substantial additional new shadows on the Playground during the times of highest use during that time of the year. This is contrary to the representations made at the time of our approval of the project. We are reserving judgment until the receipt of new, accurate boards.

Except as otherwise noted above, NABB and Trinity Church believe that these issues should be addressed in a final EIR prior to BRA action on the request for PDA approval.

Very truly, yours,

Frederick V. Casselman

cc: Mitchell Fischman
Joseph P. O'Connor
Stamen O'Gilvie

ELLIS NEIGHBORHOOD ASSOCIATION, INCORPORATED
52 Chandler Street Boston, MA 02116 542-5891

November 21, 1984

RECEIVED
NOV 21 1984
BOSTON REDEVELOPMENT AUTHORITY
OFFICE OF THE DIRECTOR

Mr. Stephen Coyle, Director
Boston Redevelopment Authority
City Hall
Boston, MA 02201

Re: 500 Boylston St. Draft EIR

Dear Mr. Coyle:

The Ellis Neighborhood Association, as a member of the Civil Advisory Committee on the St. James Garage/New England Life Project wishes to supplement the committee's comments on the <u>500 Boylston St. Project, BRA Draft Environmental Impact Report</u> with these specific concerns.

<u>In the Transportation Section:</u>

See Figure IV-1, (p.25) Study Area Location Map. The traffic effects of the project will further impact residential streets of the South End. Both Clarendon and Dartmouth Streets south of Columbus Avenue are used as commuter access to, or exit from, the Back Bay. The inclusion of this area to Tremont St. should be part of the study. This is particularly relevant with respect to the National Garage.

In analyzing the difference in traffic between Figure IV-12 (p.60) 1989 No-Build PM Peak Hour Volumes, and Figure IV-14 (p.62) 1989 Build PM Peak Hour Volumes, at the three intersections through which all traffic from the National Garage must pass, we find a confusing statistic. With 300 additional parking spaces in place in the "Built" version, only 117 more vehicles travel through these intersections each PM peak period than for the No-Build peak. 183 vehicles are unaccounted for each evening.

Table IV-27 (p.75) Intersection Analysis With and Without National Garage Expansion, does not include the intersection at Dartmouth St. and Columbus Ave. Although footnote #1 explains that only intersections experiencing a difference in activity are shown in the table, it is difficult to understand why the intersection closest to the National Garage would not register increased traffic.

<u>In the Air Quality Section:</u>

We find the results indicated in Table IV-35 (p.111) Predicted Maximum CO Concentrations, discouraging and the mitigation strategies discussed on p.112 undesirable and probably unworkable. To offset the health-threatening air quality reductions created by this project, heroic efforts are called for

on the part of the Boston Traffic and Parking Department. The emphasis is on facilitating the movement of greater volumes of traffic rather than improving the quality of our city by reducing the volume.

Removing on-street parking is a dubious mitigation strategy. Only one illegally parked or one officially parked police vehicle in front of Police Headquarters on Arlington St. will foil the plan. Not to mention the inconvenience to the public who will be deprived of on-street metered parking.

Since plans for the Tent City site are progressing rapidly, it is reasonable to assume the construction of a major parking facility on that site in the not too distant future. Tenant parking for Copley Place and the residential parking component of the projct indicate approximately 700 spaces for that location. The new Back Bay/South End Station will undoubtedly also create vehecular activity of its own.

These two projects should be included in Table IV-17 (p.55) and IV-19 (p.56) and their impacts included in the study. The two and one-half million square feet addition to the Prudential Center, while not a firm proposal at this time, does represent a quantum leap in size whose impacts should be considered.

Our concern as a neighborhood is that while perhaps no single new development project will overwhelm us, the aggregate effect of many certainly will.

Recognizing the unique qualities of our livable city, we expect the authority and regulatory agencies of the city to closely analyze this EIR and to vigorously work to safeguard Boston's special environment for present and future residents.

Very truly yours,

Kenneth Gritter
President

cc: Mitchell L. Fischman, BRA

Transportation

INTRODUCTION

The study area for the transportation analysis reported on in the BRA Draft EIR, October 1984, encompassed a relatively large area of the Back Bay and South End, bounded by Charles Street to the east, Dartmouth Street to the west, Beacon Street to the north, and Columbus Avenue to the south, except for the block between Arlington and Berkeley Streets where the study area extends to Tremont Street. This study area was an expansion of an earlier study area considered in a preliminary transportation analysis conducted in 1983 by the proponent for the Boston Redevelopment Authority (BRA) and the St. James Civic Advisory Committee (CAC).

The transportation analysis for the proposed project was conducted in three phases. The study phases are summarized briefly in this introduction and described in detail in the BRA Draft EIR and its accompanying Technical Appendix on Transportation.

The first phase involved inventorying the existing travel demand characteristics in the area. The inventory included researching previous transportation reports as well as conducting new observations of area travel demands. Traffic volume counts were conducted in 1983 and 1984 at critical locations during the morning and evening peak hours. The analysis locations included 23 key intersections, which were chosen based on input received from the BRA and the CAC. Pedestrian counts were conducted at noon as well as the AM and PM peak hours, and roadway volumes were recorded over 24-hour periods. In addition, transit line performance and ridership data were researched from MBTA files to identify existing transit levels of service. Certain data collected during the preliminary analysis in 1983 were verified by means of recounts at selected locations in 1984. The existing transportation network served as a base condition for subsequent analysis.

The second phase of the study built upon the data base compiled in the first phase and established the framework for evaluating the transportation impacts of the 500 Boylston Street Project. In this phase, travel demand forecasts for the project were assessed along with forecasted demands created by other future area developments. Estimates were made for all transportation modes; however, emphasis was placed on vehicular traffic and parking demands.

The final study phase evaluated the impacts of the project on each element of the transportation system. Mitigation measures were then identified for those situations in which adverse impacts were likely to occur.

In response to the BRA's review comments on the Draft EIR and the Transportation Appendix, some aspects of the analysis were further investigated. Subsequent analyses of traffic and parking impacts associated with the Tent City Development and the Tremont/Clarendon intersection were also performed. Clarification and elaboration of the transportation study presented in the BRA Draft EIR, as well as the results of the additional analyses, are included in this section as responses to the BRA's comments on transportation.

COMMENT 1:

The major traffic problem perceived by the Back Bay community is the additional traffic imposed on Berkeley Street, which is considered to be a neighborhood residential street. Berkeley Street, however, represents the major access to Storrow Drive, both east and west, and to Beacon Street outbound. Berkeley Street has also been identified in the Draft EIR (as well as in the EIRs of other Back Bay projects) as a seriously congested street in the evening peak period, particularly at Beacon Street. The Draft EIR also estimates the 500 Boylston contribution to the 1989 PM peak traffic on Berkeley Street at Beacon to be around 7%, so that this project is hardly the sole culprit. Nonetheless, as each new project is added, the already serious situation is further exacerbated. Therefore, it is critical that satisfactory mitigation measures be adopted to reduce substantially the number of cars using Berkeley Street between Newbury Street and Storrow Drive. Although a number of measures are suggested in the Draft EIR, others warrant investigation.

RESPONSE:

The proposed program to mitigate project-related and areawide traffic on Berkeley Street includes measures to improve traffic flow by making better use of already available capacity and implementing volume-reduction techniques. The volume-reduction techniques presented in the BRA Draft EIR included:

- o A comprehensive series of employer-based measures, such as ride-sharing programs, alternative work

hours, encouragement of public transit use through sales of commuter passes and tickets, and fully-coordinated and staffed commuter information programs.

- o Parking supply and cost policies that will result in fewer vehicle trips throughout the study area than estimated in the "worst-case" analysis.

- o A signing program for alternative routes to Storrow Drive and the Southeast Expressway.

- o Restrictions on the delivery of goods during peak hours.

Traffic operation and control improvements that would help make better use of the available capacity were cited in the Draft EIR as:

- o Signing, striping, and enforcement at specific high-volume intersections.

- o Traffic signal optimization throughout the study area.

- o Consideration of additional localized peak period parking restrictions.

- o Increased enforcement (including towing) of existing parking restrictions along critical routes.

The combination of reducing traffic and improving operations will not only help mitigate impacts on Berkeley Street directly related to the additional traffic that will be generated by the proposed project, but will aid in further reduction of adverse traffic conditions in the area. While not all the proposed mitigation measures can be quantified, certain actions such as changes in traffic operations at key intersections, as well as the reduction in vehicle-trips due to a constrained parking supply, are quantifiable in terms of level of service and volume-to-capacity ratio. Table 33B in the Draft EIR, repeated here as Exhibit IV-1, demonstrates the improved effects that would result from limiting parking supply and improving traffic operation at 6 of the 23 intersections studied, including Berkeley Street at Beacon Street. Since the absolute increase indicated in the transportation analysis for the 1989 PM peak hour at Berkeley/Beacon

EXHIBIT IV-1

Summary of Effects of Constrained Parking and Improved Traffic Operations at Selected Intersections 1/2/

Peak Hour	Intersection	1989 Build Condition: No Mitigation Actions V/C	LOS 1/	Constrained Parking V/C	LOS	Traffic Operations Improvements V/C	LOS	Combined V/C	LOS
AM	St. James/Berkeley	0.79	C-	0.78	C	-	-	0.78	C
AM	Beacon/Berkeley	0.80	C-	0.79	C-	0.69	B-	0.68	B
AM	Clarendon/Beacon	0.70	B-	0.68	B	-	-	0.68	B
AM	Clarendon/Boylston	0.79	C-	0.73	C	-	-	0.73	C
AM	Columbus/Berkeley	0.90	D-	0.88	D	-	-	0.88	D
AM	Tremont/Berkeley	0.66	B	0.65	B	-	-	0.65	B
PM	Boylston/Berkeley	0.98	E	0.96	E	0.79	C-	0.76	C
PM	Beacon/Berkeley	0.98	E	0.96	E	0.81	D+	0.79	C-
PM	St. James/Clarendon	0.75	C	0.73	C	-	-	0.73	C
PM	Arlington/Stuart/Columbus	1.09	E-	1.07	E-	0.77	C	0.77	C
PM	Dartmouth/St. James	0.86	D	0.81	D+	-	-	0.81	D+
PM	Arlington/Tremont	0.85	D	0.84	D	-	-	0.84	D

1/ This exhibit appeared originally in the BRA Draft EIR, as Table IV-33B, p. 101.
2/ Plus and minus signs indicate an LOS value close to the top or bottom of its range, (i.e., C- means near the low end of the LOS C range, close to LOS D).

was only 118 vehicles, most if not all of this increase could be eliminated through the proposed volume-reduction measures. Even with no volume reduction, the proposed signing, striping, and enforcement measures have the potential to improve the volume-to-capacity ratio for the PM peak hour at Berkeley/Beacon from 0.98 (LOS E) to 0.81 (LOS D), as shown in Exhibit IV-1.

Following publication of the Draft EIR, the proponent discussed possible additional mitigation measures with BRA staff. The one additional measure identified as potentially helping to alleviate traffic in the project area was a suggestion from the BRA that the westbound flow on Marlborough Street between Berkeley and Arlington Streets be reversed to eastbound, as it used to be, to help reduce congestion on the upper portion of Berkeley Street.

While the proponent has agreed to oversee implementation of some of the mitigation measures, all of the traffic improvement operations and the signing program for volume reduction are under the jurisdiction of the City. A coordinated effort between the City and the proponent will be necessary to mitigate traffic in the project area. The Boston Traffic and Parking Department is working toward improved traffic conditions through such measures as increased enforcement efforts, computerized traffic signal control, resident parking permit programs, and traffic circulation changes. The Department has also indicated its intention to undertake development of a master plan for traffic in the downtown area, including the Back Bay and South End.

COMMENT 2: In addition, the traffic study should be amended to include the impact of the proposed 700 car parking facility on the Tent City site.

RESPONSE: According to the Environmental Notification Form (ENF) for the Tent City proposal (noticed in the Environmental Monitor of December 24, 1984), the project will consist of 698 parking spaces in an underground garage, 270 units of residential housing above, and 5,000 to 10,000 square feet of community retail space. The parking garage will include 129 spaces dedicated to the new residential units and 569 spaces for commercial use, essentially reducing the parking shortage for employees at Copley Place, which is adjacent to the

Tent City site. Since the site already is used for Copley Place employee parking (276 spaces), only 422 new spaces will be created by the project. Since 129 of these 422 spaces must be for project residents, the remainder (293 spaces) will be available to further reduce the employee parking short- age at Copley Place.1/ These 293 spaces are already accounted for in the local street networks because the BRA Draft EIR analysis conservatively assumed that all vehicle trips generated by the various background developments estimated to be in place by 1989, includ- ing Copley Place, would be able to park at these devel- opments. The only requirement is that these trips shift their trip origin or designation from Copley Place to Tent City. Therefore, only the new resi- dential trips need to be added to the network. Other assumptions made in the analysis are as follows:

o The number of trips generated by the small amount of retail space included in the Tent City proposal would be negligible.

o Access/egress to the Tent City garage will be via Dartmouth Street, as stated in the ENF.

o Only the residential units actually allocated park- ing spaces in the Tent City garage will generate vehicle trips. As stated in the ENF, it is expec- ted that access to the residential portion of the project will be mainly by foot and public transpor- tation, given the urban nature of the location. A small number of street-level spaces (39 spaces) will be provided on the Yarmouth Street side of the site, with negligible impact on Dartmouth Street.

o As stated in the BRA Draft EIR (Table IV-12), 55 percent of the daily employee-related traffic to or from the garage would actually occur during the AM or PM peak hour. It was assumed that the same percentage was applicable to residential traffic.

1/ As noted in the "Certificate of the Secretary of Environmental Affairs on the Final EIR" [for Copley Place], dated October 30, 1980, the calculated shortfall for Copley Place was estimated to be between 433 and 673 employee parking spaces.

- The same trip distribution percentage used in the BRA Draft EIR (Table IV-20) was applied to Tent City traffic. This distribution was derived from the Copley Place Draft EIR.

- The intersections most likely to experience traffic impacts from the Tent City project include Dartmouth/Stuart, Dartmouth/Columbus, Dartmouth/St. James, and Columbus/Clarendon. Traffic effects at other locations are minimal due to traffic dissipation with increasing distance from the Tent City site.

Based on the above, the change in level of service (LOS) and volume-to-capacity (V/C) ratio for the PM peak hour build condition at the four analysis locations is presented in Exhibit IV-2.

EXHIBIT IV-2
TENT CITY PROJECT INTERSECTIONS
LEVEL OF SERVICE ANALYSIS FOR 1989 BUILD PM PEAK HOUR

	Without Tent City		With Tent City	
Location	V/C	LOS	V/C	LOS
Dartmouth/Stuart	0.52	A	0.55	A
Dartmouth/Columbus	0.57	A	0.59	A
Dartmouth/St. James	0.86	D	0.86	D
Columbus/Clarendon	0.74	C	0.75	C

Therefore, it can be stated that the Tent City project has relatively little impact on the analysis results presented in the BRA Draft EIR, and does not change any of the conclusions or recommendations. This would still be true even if some of the commercial spaces in the Tent City Project are reserved for short-term (e.g., shopper) parking. Somewhat smaller impacts would result from this type of parking, which is spread more evenly throughout the day than the more concentrated in/out peak hour patterns for employee parking.

COMMENT 3:

[Ref. Figures IV-5 and 6, also Figures IV-11, 12, 13, 14, BRA Draft EIR]
There is a considerable discrepancy in flow volumes between adjacent intersections so that the flows do not balance out. Why does this occur, especially when there are no major generators (e.g., parking facility) between the intersections which could account for a difference?

RESPONSE:

Investigation of Figures IV-5 and 6 1/ indicates that the reasons for the differences occurring between "adjacent" intersections are intervening streets, parking facilities, or both. As noted on the figures, which are schematic, only streets included in the traffic analysis are shown. Following are some examples of intervening streets that are excluded:

- o Marlborough Street
- o Newbury Street
- o River, Brimmer, and Beaver Streets intersecting Beacon Street between Charles and Arlington Streets
- o Trinity Place intersecting St. James Avenue between Clarendon and Dartmouth Streets
- o Morgan and Cazenove Streets intersecting Columbus Avenue between Berkeley and Clarendon Streets
- o Warren Avenue and Gray, Appleton, Lawrence, Chandler, and Cortes Streets intersecting Berkeley Street between Columbus Avenue and Tremont Street.

The flow volumes shown on Figures IV-5 and 6 are generally representative of actual counts at individual intersections. Certain locations were counted for the 1983 study, some of these were recounted in 1984 for the present study, new locations were added and counted in 1984, and additional counts were obtained for various years as available from the Boston Traffic and Parking Department. Due to the variety and number of analysis locations, it was decided to use the actual

1/ This discussion also applies to the other figures mentioned in the comment, since they are based on the data in Figures IV-5 and 6.

peak hour counts at each location, except in those cases where obvious inconsistencies existed, such as locations affected by construction activity (see response to Comment 4). To balance flows would have been virtually impossible and would not necessarily have been more indicative of actual operating conditions. Since each location was analyzed during its own peak hour rather than developing a system-wide peak hour (see response to Comment 27), normal differences in peaking times occur even between adjacent intersections and, along with parking activity, result in some variation between these locations. Where more than one count was available for an intersection, the larger was generally used to be conservative, again contributing to some apparent imbalance.

COMMENT 4:

In comparing the traffic volumes in Figure IV-5, 6 (existing peak hour volumes) with the peak hour turning movement counts presented in Appendix 2, there are several noticeable discrepancies and in some cases the differences in volumes are quite significant (e.g. over 200 vehicles). This should be explained.

RESPONSE:

As noted in the response to Comment 3 above, traffic counts which were significantly affected by construction activity (mostly in the Columbus/ Dartmouth/Clarendon/Berkeley area) were adjusted to account for traffic detours. Technical Appendix 2 on Transportation, which accompanied the BRA Draft EIR, shows the raw (unadjusted) counts while Figures IV-5 and 6 reflect the adjusted volumes. Three intersections were particularly affected by localized circulation changes during the 1983 and 1984 count program: St. James/ Dartmouth, Stuart/Dartmouth, and Columbus/Berkeley.

St. James/Dartmouth and Stuart/Dartmouth are both in the area affected by Copley Place construction activity during the 1983 counting period. Traffic circulation changes in this area were made prior to the 1984 count program, resulting in a traffic redistribution at these locations. As an example of how conditions changed in this area from 1983 to 1984, the table below summarizes the total PM peak hour volume entering each intersection based on counts made in each year, and the difference in terms of volume and percent change:

INTERSECTION	PM PEAK HOUR VOLUME 1983	1984	VOLUME DIFFERENCE	PERCENT CHANGE
St. James/Dartmouth/Huntington	2100	2467	+367	+17.5
Stuart/Dartmouth	1082	2358	+1276	+117.9

This difference in volume resulted from a blockage of Dartmouth Street south of Stuart Street in 1983, as well as a change in traffic flow patterns on Huntington Avenue and Dartmouth Street. In 1983, Huntington Avenue and Dartmouth Street were both two-way. In 1984, Huntington Avenue was one-way westbound and Dartmouth Street was one-way northbound.

The Columbus/Berkeley intersection was similarly affected by construction activity, both in 1983 and 1984. Subsequent to the preliminary 1983 report, additional traffic volume data were obtained along Columbus Avenue from City of Boston counts. These showed that existing traffic prior to construction was substantially higher than originally anticipated during the 1983 analysis. Therefore, corrections were made in the 1984 BRA Draft EIR which accounted for traffic detours and which brought this location into conformance with available data sources.

COMMENT 5:

[Ref. Figure IV-7, BRA Draft EIR]
The basis for the parking supply numbers should be specified. In some cases they differ from the numbers shown on the City's parking facility map (see Figure 6.2-1 of the Hynes Auditorium EIR).

RESPONSE:

Parking capacities shown for major existing parking facilities in Figure IV-7 were generally based on the April 1981 BRA parking inventory and map (which is reflected in Figure 6.2-1 of the Hynes Draft EIR) and the 1982 Boston Parking Survey1/, but were modified in two instances by updated information from actual garage surveys conducted for the 500 Boylston Street project by Vanasse/Hangen Associates, Inc.: the

1/ As reported in "Parking in Central Boston," Cambridge Systematics, Inc. and Vanasse/Hangen Associates, Inc., September 1983.

National Garage (plus the lot in front of the garage) is listed as 460 total spaces in the BRA inventory, actual counts indicate a capacity of 490; the facility at Dartmouth/Newbury Street is listed as 71 in the inventory, actual counts indicate a total of 85 (not 90 as shown in the BRA Draft EIR). Concerning additional differences, the Boylston Street total of 120 is a rounded value comprised of two separate facilities: BRA Code No. 225 (80 spaces) and BRA Code No. 239 (41 spaces). Finally, the 1,157 shown at Copley Place was obtained from the BRA inventory but incorrectly shown in the BRA Draft EIR as one facility instead of two (updated BRA capacities for these two facilities are 275 and 860, as noted in Comment 63, which appears at the end of this section.)2/

COMMENT 6:

[Ref. Tables IV-7 and IV-8, BRA Draft EIR]
The City's report "Parking in Central Boston" indicated for the Back Bay a modal split (% auto) of 40-55 percent for work trips and 48-52% for non-work trips. While it is recognized that the office split is based on actual surveys of existing insurance companies, might not the retail trips be somewhat underestimated, being 30% and 40% respectively? The same report also assumed a vehicle occupancy rate of 1.51 for work trips and 1.31 for non-work trips (vs. 1.4 and 1.9 for the retail). Again, non-work vehicle trips may be underestimated.

RESPONSE:

The respective assignment of 30 percent and 40 percent for retail work and non-work trips made by vehicle (as opposed to using transit or walking), were derived from the Copley Place Draft EIR which, in turn, was based on extensive research on this question. As stated in that report, the nature of the Back Bay location with respect to improved transit access, the type of retail clientele expected, the impulse shopping factor, and various other elements all contributed to the decision on the auto mode split percentages. As stated in the Copley Place Draft EIR, these "were established with

---

2/ As an informational update, a parking freeze permit application has been received by the Boston Air Pollution Control Commission to increase the capacity of the Hancock Garage by 150 spaces by restriping the existing facility, but this has not yet been done.

reference to...available data describing modal splits currently experienced in downtown Boston and the Back Bay, and in consultation with the Neighborhood Association of the Back Bay and representatives of the Boston Redevelopment Authority, the City of Boston Traffic and Parking Department, the Central Transportation Planning Staff and the Massachusetts Turnpike Authority." The retail vehicle occupancy rates were also derived from the Copley Place Draft EIR data, which were based on similar research. Also, the occupancy rates of 1.51 for work trips and 1.31 for non-work trips reported in "Parking in Central Boston" are for the entire downtown area. Rates recorded in that report for an existing office building on the 500 Boylston Street project site are 1.90 and 1.72, respectively. Finally, since the retail component of the total new 1989 vehicle-trips generated by the project is so small (two of 530 AM peak hour trips and 24 of 624 PM peak hour trips), even a 50 percent increase in the retail numbers would only add 1 AM vehicle trip and 12 PM vehicle trips, a negligible change. Similar changes in the vehicle occupancy rate used, even if warranted, would have virtually no impact on the analysis results.

COMMENT 7:

[Ref. Table IV-12, BRA Draft EIR]
The peak hour trip generation data made no allowance for AM peak hour employee vehicle departure or PM peak hour employee vehicle arrival. Support for this assumption should be provided or the tables revised. Do the "all vehicle" figures include employee drop-off, taxi arrivals/departures and deliveries?

RESPONSE:

These statistics were also based on the Copley Place Draft EIR which showed no reverse direction activity. These were adapted from findings of the Park Plaza Project transportation impact report.1/

In reality, there probably will be reverse tripmaking for office work and non-work trips during the conventional AM and PM peak hours, but it is judged to

1/ "Transportation Impacts of the Park Plaza Urban Renewal Project," Cambridge Systematics, Inc., July 1975.

be very small, with negligible incremental impact on traffic flow.

The "All Vehicle" figures in Table IV-11, as noted on page 50 of the BRA Draft EIR (and subsequent tables), include personal auto, carpool, vanpool, and taxi traffic. Delivery truck traffic was estimated separately on page 53 of the BRA Draft EIR and combined with other site-generated traffic.

COMMENT 8:

In the discussion of future base traffic, it does not appear that an annual growth in regional traffic, independent of traffic generated by new developments in the Back Bay, has been taken into account. If this information is available it should be analyzed.

RESPONSE:

Evidence reflected in the following exhibits suggests that addition of an annual traffic growth factor beyond specific development-generated traffic is not warranted. As shown in Exhibit IV-3, comparison of data from the 1972 and 1982 Downtown Boston Cordon Counts indicates that whereas total vehicle crossings for all cordon stations increased by about 15 percent, crossings at Back Bay/South End stations decreased by almost 9 percent. Other data for specific intersections in this area also indicate general traffic stability over time (see Exhibits IV-4 and 5).

Smaller-scale land use changes than those specifically accounted for in the BRA Draft EIR may generate small additional amounts of traffic. However, the BRA Draft EIR analysis approach of choosing conservative (i.e., higher volume) assumptions in all cases where a choice was required, assures that these possibilities are already accounted for without adding an annual growth rate beyond the traffic increases generated by planned development projects.

COMMENT 9:

[Ref. Figures IV-11, 13, BRA Draft EIR]
The 16 percent of the project-generated (and presumably other new development) traffic coming from the north and northeast presumably comes down Storrow Drive to the Arlington Street off-ramp to Beacon Street. How-

EXHIBIT IV-3
HISTORICAL VOLUME TRENDS FOR
BACK BAY/SOUTH END STATIONS1/

Survey Station	Vehicle Crossings (6:00 AM - 12:00 Midnight) 1972	1982	
Beacon Street	12,176	6,567	
Marlborough Street	1,965	2,107	
Commonwealth Avenue	29,367	29,848	
Newbury Street	859	1,638	
Boylston Street	12,656	11,469	
Haviland Street	1,330	1,255	
Westland Street	9,393	10,783	
St. Stephen Street	1,475	2,119	
Huntington Avenue	19,859	21,150	
St. Botolph Street	2,769	2,959	
Columbus Avenue	18,245	14,076	
Tremont Street	17,830	8,330	
Storrow Drive	84,530	81,401	
	212,454	193,702	(-8.8%)
All Cordon Stations	844,141	969,149	(+14.8%)

1/ From "Cordon Count 1982, Downtown Boston," Boston Traffic and Parking Department.

EXHIBIT IV-4
HISTORICAL VOLUME TRENDS FOR
BACK BAY ROADWAYS

Roadway	1977 AWDT1/	1982 Cordon2/	1983-1984 500 Boylston St.3/
Storrow Drive EB (west of Clarendon Street exit)	47,579	45,047	
Boylston Street EB (west of Berkeley)	19,496		17,900
Columbus Avenue EB	8,407		9,300
Berkeley Street NB (south of Columbus)	10,189		11,700
Tremont Street NB (west of Arlington)	10,097		9,200
Arlington Street SB	18,270		22,700
Charles Street NB	26,900		22,800
(north of Boylston)	(45,170)		(45,500)
Harvard Bridge (two-way)	32,207	31,500	
Longfellow Bridge EB	11,458	12,372	

1/ Average Weekday Traffic from "Boston Central Artery, 1977 Origin-Destination Study," Massachusetts Department of Public Works, November 1978.
2/ From "Cordon Count 1982, Downtown Boston," Boston Traffic and Parking Department.
3/ Counts taken for the 500 Boylston Street Project.

EXHIBIT IV-5
HISTORICAL VOLUME TRENDS FOR
BACK BAY INTERSECTIONS

Intersection	Volume and Year		Percent change per year
Beacon/Arlington1/	1982 4,617	1984 3,473	-13.3
Boylston/Dartmouth1/	1980 2,028	1984 2,216	+2.2
Arlington/Boylston1/	1981 2,568	1983 1,953	-12.8
Columbus/Berkeley1/	1973 2,223	1981 1,736	-3.0
St. James/Berkeley1/	1979 1,781	1983 1,750	-0.4
Boylston/Clarendon1/	1979 1,941	1983 1,938	-0.1
Beacon/Mass. Ave.2/	1978 8,953	1981 8,058	-2.6
Beacon/Dartmouth2/	1976 11,342	1980 10,725	-1.4
Boylston/Mass. Ave.2/	1975 10,269	1981 10,188	-0.1

1/ Source: Various traffic counts; PM peak hour entering volumes
2/ Source: BRA Staff Memo to Boylston Street Zoning Study Citizens Review Committee, July 19, 1984; 11 hour counts.

ever the volume increases on Beacon Street (1989 No-Build vs. 1984, 1989 Build vs. No-Build) do not reflect this, showing lesser increases. This should be explained or appropriate corrections made.

RESPONSE:

The percentages shown in Figure IV-10 (Figures IV-11 and IV-13 mentioned in the comment deal with volumes) are not specific route assignments but rather regional corridor aggregations of the more detailed breakdowns given in Table IV-20. Traffic actually assigned to the Arlington Street off-ramp from Storrow Drive westbound was 11 percent (north) from Table IV-20 rather than the 16 percent of Figure IV-10. Sixteen percent is derived by combining (from Table IV-20) 11 percent northeast and one-half of 11 percent north (after rounding). Likewise the 15 percent value in Figure IV-10 is comprised of 9 percent northwest and one-half of 11 percent north (after rounding). Also, not all of the traffic from other new development projects was assigned in exactly the same way as 500 Boylston Street traffic. The location of each project dictated the actual assigned route. As an example, whereas traffic exiting Storrow Drive at Arlington Street which is destined to 500 Boylston Street was assigned to Beacon Street westbound into Clarendon Street southbound, traffic destined to the State Transportation Building or the Four Seasons development in the Park Plaza area was assigned from the same Arlington Street off-ramp to Beacon Street eastbound into Arlington Street southbound.

COMMENT 10:

[Ref. Figure IV-14, BRA Draft EIR]
Why is there less traffic on Boylston Street, going straight, in front of the project site under the build condition than under the no-build condition?

RESPONSE:

The difference of three vehicles per hour is due to a drafting error. The correct volume is 972 vph for both the 1989 no-build and build conditions. The small discrepancy has virtually no effect on the traffic analysis. The volume under build vs. no-build conditions is the same because of the location of entrances and exits to the 500 Boylston Street parking garage. The lack of an entrance or exit on the Boylston Street

side of the project, combined with the one-way street pattern and the assumption that in/out movements would occur in the most efficient way, results in virtually no volume increase on this street segment.

COMMENT 11:

There is a question as to whether the vehicular capacity calculations tend to overestimate the level of service which an intersection might create. The following points [see Comment 12 or the second point] on methodology should be noted:

- Where pedestrian activity is high and exclusive pedestrian signal phase is in use or indicated, the capacity calculations simply use the capacity per hour of green table with an additional phase. This does not compensate in any significant way for an exclusive pedestrian phase. Many of the intersections in the study area (e.g., Boylston and Arlington) are affected in this way.

RESPONSE:

As stated on page 65 of the BRA Draft EIR, pedestrian activity was taken into account at all locations by increasing effective right-turn volumes used in the analysis by 25 percent to simulate interference from pedestrians (i.e., adding right turns compensates for the reduced intersection capacity due to pedestrian conflict with turning vehicles). This is based on guidelines given in TRC1/ 212, "Interim Materials on Highway Capacity." Where pedestrian activity is particularly high (e.g., along Boylston and Dartmouth Streets), additional compensation in the form of an extra signal phase was included to account for lost green time due to pedestrian interference with through movements. Left turns were increased by at least 20 percent at all locations to account for interference with this movement. In those cases where opposing flows were large (on two-way streets only) even larger left-turn factors were used, again based on TRC 212 guidelines. Exclusive pedestrian phases would impact certain locations where they are employed to an even greater extent if they were called by a pedestrian during every phase. Field observations indicated,

1/ TRC = Transportation Research Circular

however, that such constant usage is not the normal type of operation (with the exception of the Beacon/ Charles intersection; see response to Comment 30). Therefore, the corrections discussed here were considered sufficient.

COMMENT 12:

On multi-lane approaches for the same movement, there is no allowance for unequal distribution of cars between the lanes, thereby presuming an efficiency that is not there. The analysis should clarify this.

RESPONSE:

The analysis procedure follows the recommendations in TRC 212 for the assignment of lane volumes. It results in unequal lane distribution in certain cases (usually where turns and through movements are permitted from shared lanes) and equal distribution in others (usually where turning movements are separated from through movements by exclusive turn lanes). Inspection of the lane assignments in the Technical Appendix 2 of the BRA Draft EIR will indicate many instances of unequal lane distribution which result from application of this procedure.

COMMENT 13:

[Ref. p. 65, BRA Draft EIR]
A Level of Service "F", where the V/C ratio exceeds 1.00, should be included on Table IV-22 and in the discussion. Stuart at Arlington falls into this category in the P.M. peak hour, representing a degradation from the existing condition.

RESPONSE:

Table IV-22 from the BRA Draft EIR is amended to include level of service F, and presented here as Exhibit IV-6.

As pointed out in TRC 212, there is no volume range nor V/C ratio applicable to LOS F, since the stop-and-go operation which is characteristic of this service level can occur at any volume, and is usually the result of conditions external to the location being analyzed. The rationale for applying LOS E to signalized intersections where the V/C ratio is greater than 1.0 is based on the following:

- LOS F should be used only for situations where intersection congestion is due to external causes

EXHIBIT IV-6
(REVISION OF TABLE IV-22, BRA Draft EIR)
LEVEL OF SERVICE CRITERIA
FOR SIGNALIZED INTERSECTIONS1/

Level of Service	Maximum Sum of Critical Volumes: Two Phase	Three Phase	Four Phase	Volume/ Capacity Ratio
A	900	855	825	0.00-0.60
B	1,050	1,000	965	0.61-0.70
C	1,200	1,140	1,100	0.71-0.80
D	1,350	1,275	1,225	0.81-0.90
E	1,500	1,425	1,375	0.91-1.00
F	N O T	A P P L I	C A B L E	Varies

1/ Transportation Research Circular Number 212. "Interim Materials on Highway Capacity," Transportation Research Board, Washington, D.C., January 1980.

(e.g., backups from upstream locations). This condition does not occur at the Stuart/Arlington intersection referred to in the comment.

- o An intersection where vehicles cannot make it through the signal within one cycle (assuming no backups from other locations) is operating at maximum throughput, regardless of how long the approach queues are.

- o The primary determinant in intersection LOS should be the delay experienced by motorists waiting in the approach queues. This will be the principal criterion in the new Highway Capacity Manual, but is not now part of the evaluation procedure.

- o The use of 1.0 as the upper limit for LOS E is generally regarded as somewhat conservative since research indicates many examples of high-volume traffic operation which exceed theoretical capacity values but which are not in the congested stop-and-go, or forced-flow range.

- o Traffic degradation (or improvement) is more properly shown by a quantitative V/C measure than

by a qualitative LOS, which is simply a range of values. For any LOS, one can experience degradation of 10 percent or more in V/C ratio and still be in the same LOS range. Similarly, one can calculate a drop in V/C ratio of only 0.01 and show a change in LOS if it happens to be at the break point between two different LOS ranges. For these reasons, V/C ratios were presented in the BRA Draft EIR for all locations and analysis conditions, rather than just Level of Service values.

With respect to the Stuart/Arlington/Columbus intersection mentioned in the comment, a significant improvement in V/C ratio can be achieved by implementing the proposed mitigation measures cited on page 86 of the BRA Draft EIR, going from 1.09 (LOS E) to 0.77 (LOS C) during the 1989 PM peak hour.

COMMENT 14:

Dealing with the future parking supply and demand for short-term parkers, we see that 835 vehicle arrivals per day (pg. 52) demand 140 short-term spaces (pg. 71). This implies a turnover rate of about 6 per day, which seems excessive. The short-term demand is probably underestimated and should be reexamined in the Final Report.

RESPONSE:

Several factors were combined to estimate the short-term parking demand, including daily non-work vehicle trips generated by the project, expected average parking duration, on street parking supply in the area, parking price structure, and length of day included in the analysis. Average duration for on-street (short-term) parking in downtown Boston ranges from about 1.3 hours to 3.3 hours, with an average of about 1.8 hours. The Back Bay area averages about 1.6 hours. The scarcity of available short-term parking in the area would tend to increase the intensity of usage and result in virtually constant demand for the new spaces. The price structure assigned to these short-term spaces was assumed to be such as to discourage all-day (long-term) demand, thereby decreasing the average duration and making more of these spaces available throughout the day for shoppers, personal business, meetings, etc. Finally, the assumed length of day was nine hours (9:00 AM - 6:00 PM) as opposed to

the seven hours (10:00 AM - 5:00 PM) included in the Downtown Boston Parking report. All of these factors tend to result in a higher turnover rate for the project than the averages reported for Boston as a whole and a shorter duration than the Back Bay average. A turnover of 6.0 was calculated (9 hours/1.5 hours average duration). Survey data indicate on-street turnover rates in the 5-to-9 range on individual streets in areas of high short-term parking demand. It should also be noted that this calculation resulted in an additional demand of 140 short-term spaces (beyond the 75 now provided), although the actual number of new spaces to be provided by the proponent will be 240.

In the event that future parking characteristics are such that the anticipated turnover rate is not achieved, the 100 additional spaces actually provided would eliminate the possibility of a shortage of short-term spaces. Use of all 240 spaces in the parking analysis is equivalent to a turnover of about 3.5 (i.e., if a turnover rate of 3.5 had been used instead of 6.0, the required number of new short-term spaces would be 240, the number actually to be provided by the proponent.)

COMMENT 15:

[Ref. p. 72, BRA Draft EIR]
The analysis makes strong assumptions on the expansion of the National Garage by 300 spaces for employee parking. Although New England Life is pursuing this matter at present, there is no assurance that this will occur. Without it, the estimated parking shortfall would be 675 spaces, this on top of a projected Back Bay shortfall of 1700 public off-street spaces by 1985. The Final EIR should indicate a resolution of this potential problem should the National Garage not become available.

RESPONSE:

Although the proponent intends and is seeking to implement the 300-space expansion of the National Garage, the proponent recognizes the potential for a long-term parking shortfall of 675 spaces if the National Garage is not expanded, as was stated in the BRA Draft EIR. If the National Garage spaces were not available, the proponent would consider a valet/attendant parking program at the 500 Boylston Street parking garage.

As noted on page 75 of the BRA Draft EIR, the traffic analysis considered a scenario in which the 300 parking spaces from the National Garage were accommodated in the 500 Boylston Street garage. The analysis indicated little difference in volume-to-capacity ratios at the study area intersections and virtually none in terms of level of service.

COMMENT 16:

[Ref. p. 72, BRA Draft EIR]
There is some confusion between the definition of types of parking which exist now and which are proposed for the future. Today the St. James Garage has about 625 spaces which are mainly open to the general public for a fee on a daily basis. Around 75 spaces are kept open in the morning until after the peak hour so that this number might be available for non-commuters, assumedly short-term parkers. There is not (officially) a larger number of spaces leased on a monthly basis. The point is that the existing garage is open to the public on a daily basis.

RESPONSE:

The 625 spaces (550 long-term plus 75 short-term) in the existing St. James garage are available to the public daily. The proponent has proposed that the same total number will continue to be available to the public, except that there will be 315 short-term spaces and 310 long-term spaces in the new garage to be leased to the public by the month using a lottery selection system, with all interested parties given an equal opportunity for getting a space. Both are public uses, the difference being only in how they are administered. The proposed type of management would tend to reduce travel around the site by discouraging some motorists who would normally drive in with the hope of finding a space. If all of the public has a chance at these long-term spaces on a day-to-day basis, more people may drive than if a prescribed number of users are given a space for the month. Three hundred and fifteen spaces will be available for short-term users.

COMMENT 17:

[Ref. Table IV-27, BRA Draft EIR]
Intersection Analysis With and Without National Garage Expansion, does not include the intersection at Dartmouth Street and Columbus Avenue. Although footnote #1

explains that only intersections experiencing a difference in activity are shown in the table, it is difficult to understand why the intersection closest to the National Garage would not register increased traffic.

RESPONSE:

The analysis for "Without National Garage Expansion," as stated on pg. 75 of the BRA Draft EIR, represents the condition where all demand for parking generated by the project parkers (including the 300 additional stalls at the National Garage) are theoretically accommodated at the 500 Boylston Street site. Therefore, the same number of vehicles are present on the street network, only assigned somewhat differently due to the change in final trip origin or destination depending on direction. At the intersection in question (Dartmouth/Columbus), the same traffic volumes must be handled regardless of whether parking occurs at 500 Boylston Street or the National Garage. The condition where the 300 additional parkers are simply removed from the street system, thereby resulting in improved traffic operation, was not analyzed.

COMMENT 18:

[Ref. Table IV-30, BRA Draft EIR]
Why is there a difference in the P.M. peak hour ridership estimates between the two EIRs [500 Boylston Street BRA Draft EIR and Hynes Auditorium Expansion EIR], which account for the same areawide development? Also, Orange Line southbound 1983 and base condition ridership figures are different (6,700 vs. 6,500 and 10,300 vs. 10,100, 500 Boylston and Hynes respectively). Why? (Similarly, in Table IV-28, total new transit trips is given as 29,000 whereas the same table in the Hynes EIR gave 30,100. What accounts for the difference?)

RESPONSE:

The Hynes EIR used a higher "design event day" condition more applicable to planning for convention activity. The 500 Boylston Street BRA Draft EIR used a lower but more appropriate "typical event day" condition for the Hynes project. The design event level is less than or equal to about 95 percent of the total event days, whereas the typical event condition is less than or equal to 77 percent of the total event days. Therefore, all future ridership estimates are higher in the Hynes EIR. The small difference of 200 riders for

the 1983 PM peak and base conditions is due to an updated MBTA count obtained for the 500 Boylston Street project. The new count was not received in time for inclusion in the Hynes EIR.

COMMENT 19:

[Ref. p. 80, BRA Draft EIR]
The noontime pedestrian volume from the project appears to be underestimated, especially considering that the project will provide some 1,400 jobs and a considerable number of these employees can be expected to leave the building during the noon hour.

RESPONSE:

The volumes as reported in the BRA Draft EIR were estimated for a typical "off-peak" hour rather than the heavier noontime period and tend to understate noontime pedestrian volumes. If one takes as a starting point the total new work trips produced by the project as shown in Table IV-10 of the Draft EIR (8,500 office work trips plus 200 retail work trips per day), a total of 8,700 two-way person-trips are potentially assignable to the noon hour, assuming that all who work in the building will leave and return during that hour. It is assumed that one-half of the employees will leave the building at lunch time and, of those who do, not all will leave and return in the same noon to 1:00 PM period (again, say one-half will do so). Therefore, an estimate of about 2,200 pedestrian trips (8,700 x 0.5 x 0.5) seems reasonable. Distributing this number according to the percentages given in Table IV-31 of the Draft EIR and combining with existing noon-hour pedestrian volumes around the site results in higher "Combined Average Pedestrian Flow Volumes" in terms of pedestrians per foot per minute, but no change in level of service, which remains at A. A revised Table IV-32, presented on the following page as Exhibit IV-7, which also includes corrections of several minor arithmetic errors found in the BRA Draft EIR version of the table. All pedestrian level-of-service values remain at A.

COMMENT 20:

[Ref. p. 82 ff, BRA Draft EIR]
Among the mitigation measures to which the developer should give consideration are the following:

EXHIBIT IV-7
(REVISION OF TABLE VI-32, BRA DRAFT EIR)
PEDESTRIAN LEVEL OF SERVICE SUMMARY ANALYSIS

Street and Time	Effective Sidewalk Width (feet)	Direction	Existing Hourly Volume	Project Hourly Volume	(PFM) Combined Average Pedestrian Flow Volume	LOS1/
Boylston Street	19					
AM		EB	195	1,210	2	A
		WB	204	400	2	A
Noon		EB	968	1,100	4	A
		WB	969	1,100	4	A
PM		EB	885	450	3	A
		WB	816	1,360	3	A
Clarendon Street	9					
AM		NB	255	640	2	A
		SB	212	160	2	A
Noon		NB	370	550	3	A
		SB	316	550	3	A
PM		NB	204	180	3	A
		SB	478	720	3	A
St. James Avenue	10					
AM		EB	67	160	1	A
		WB	126	160	1	A
Noon		EB	143	220	1	A
		WB	133	220	1	A
PM		EB	265	180	1	A
		WB	131	180	1	A
Berkeley Street	11					
AM		NB	179	320	1	A
		SB	133	160	1	A
Noon		NB	780	220	3	A
		SB	553	220	3	A
PM		NB	246	180	2	A
		SB	215	360	2	A

1/ Pedestrian Planning and Design by J. J. Fruin: level of service (LOS) criteria based on sidewalk width and pedestrian flow.

(1) Subsidization of employee costs for public transit to the same extent that employee parking is subsidized.

(2) Implementation of the MBTA Pass Program through payroll deduction, or as an employee benefit (see (1) above) to make public transportation more attractive.

(3) Institution of a variable work hours program, to alleviate rush hour congestion (and improve air quality at the same time).

These should be discussed in the Final EIR.

RESPONSE:

New England Life currently employs, and intends to continue to employ, several methods to promote the use of public transit, carpooling, and other measures to reduce traffic. These include:

- Preferential treatment for carpools.
- On-going communication with Caravan and assistance with their program at New England Life.
- Publication of promotional material in company publications and company-wide mailings.
- In-company sales of MBTA passes.
- Designated space for commuter information.
- Open communications with the John Hancock and Liberty Mutual Insurance Companies regarding carpooling and other parking/traffic issues.
- Carpool matching service.
- Secure bicycle storage area at the garage entrance to New England Life's main building at no charge.
- Flex-time policy.
- Parking/Transportation Administrator designated within the Special Services Department of New England Life.

In addition, the proponent will undertake the following measures in connection with the project:

- o Bicycle rack(s) on the first below-grade parking level.

- o Designated space in the project for commuter information regarding public transit routes, schedules, fares, carpools, and pass ticket programs.

- o Carpool and/or vanpool matching services to employees in the project.

- o Publication of mass transit promotional materials in project publications.

- o Provision of commuter ticket and T-pass sales.

- o The investigation and implementation, if economically feasible, of a vanpool and/or carpool program within the project. This investigation will consider a program with New England Life, neighboring companies and organizations and with Caravan.

COMMENT 21:

[Ref. p. 91, BRA Draft EIR]
The impact (e.g. change in V/C ratios, LOS) of diverting flows onto alternate routes should be assessed.

RESPONSE:

Impacts associated with the alternate route to Storrow Drive eastbound, assuming the reversal of Charles Street, are provided on page 90 of the BRA Draft EIR. Included in this response is an analysis of the two other potential routes which are shown in Figure IV-20 and discussed on page 91 of the BRA Draft EIR. These include an alternate route to Storrow Drive westbound via Commonwealth Avenue and Charlesgate East and an alternate route to the Southeast Expressway via Columbus and Massachusetts Avenues. The former will improve the northerly section of Berkeley Street.

If it is assumed that 10 percent of the 1,200 to 1,500 vehicles per hour during the 1989 build PM peak hours are diverted (not including the 10 percent assumed from the Charles Street reversal), the intersection at Beacon/Berkeley, and others along Commonwealth Avenue will be affected as shown below:

Location	Without Diversion V/C	LOS	With Diversion V/C	LOS	Percent Change
Beacon/Berkeley	0.98	E	0.92	E	+.06
Berkeley/Commonwealth	0.88	D	0.89	D	-.01
Clarendon/Commonwealth	0.62	D	0.62	D	0
Dartmouth/Commonwealth	0.57	A	0.63	A	-.06

If a similar 10 percent diversion of Arlington Street through traffic (about 1,000 vph in the 1989 build PM peak hour is assumed), the Columbus Avenue route will improve traffic at several intersections as follows:

Location	Without Diversion V/C	LOS	With Diversion V/C	LOS	Percent Change
Arlington/Stuart Columbus	1.09	E/F	1.05	E/F	+.04
Arlington/Tremont	0.85	D	0.83	D	+.02
Clarendon/Columbus	0.75	C	0.76	C	-.01
Dartmouth/Columbus	0.57	A	0.58	A	-.01
St. James/Clarendon	0.75	C	0.78	C	-.04

COMMENT 22:

Retiming of the Back Bay's traffic signal system may have beneficial impacts, but there is as yet no City commitment to proceed with this (similarly with the proposed intersection-related measures). The assumption that allocating more green time for Berkeley at the expense of Beacon would be beneficial may be questionable, since Beacon Street also backs up during the rush hour.

RESPONSE:

The Boston Traffic and Parking Department is engaged in an on-going project to upgrade signal systems throughout the City, including the Back Bay and South End areas, over the next few years. As this modernized computer-controlled network comes on-line, opportunities for even further improvements in timing will emerge. The BRA Draft EIR has recommended that the City make the most of these opportunities, including other areawide mitigation measures as well (e.g., alternate route directional signing, additional peak-period parking restrictions, increased enforcement including towing in critical areas, and peak period goods delivery restrictions), but the proponent cannot implement these mitigation measures.

Concerning the specific intersection at Beacon/ Berkeley, observation indicates that queuing on Berkeley Street occurs more frequently and is of longer duration than on Beacon Street. This leads to the suggestion that the Boston Traffic and Parking Department consider retiming here and at other locations.

COMMENT 23:

[Ref. p. 96, BRA Draft EIR]
The conclusion that most or all of the parking shortfall will shift to public transportation may not be entirely realistic. The excess capacity of the Green and Orange Lines is useful only if one lives in an area served by these lines, but there is no guarantee that all of the shortfall would live in such areas. Therefore, the assumption in shift of modes is highly optimistic.

RESPONSE:

As stated in the response to Comment 15, some of the parking shortfall could be accommodated by valet/ attendant parking, some by increased vehicle occupancy rates, and some by shifts to public transportation. The latter includes commuter rail, bus, and rapid transit. The coverage area for these public transportation modes is considerable since one-transfer connections to the Green and Orange Lines are available from either the Red or Blue Lines. That people are willing to transfer during their public transportation commute is shown in the MBTA's statistics for 1976 to 1981 on trips by mode. Those who used surface modes only (bus or surface streetcar) comprised 21 percent of

total ridership, those who used only rail rapid transit were 8 percent, and those who used both were 71 percent of all MBTA riders.

COMMENT 24: [Ref. Figures IV-6, 12, and 14]
On traffic volumes, it appears that the peak hour volumes on Clarendon Street south of Stuart Street and south of Columbus Avenue may be exaggerated, seeing that they are higher than north of Stuart and the Mass. Turnpike ramp is a traffic bleeder. This should be reviewed since it is of such importance to the South End community.

RESPONSE: The Hancock Garage has an exit onto Clarendon Street. Exiting vehicles from the garage, combined with right-turning traffic from Stuart Street and left-turning traffic from Columbus Avenue from the National Garage, continue south on Clarendon Street to access points in the southeast to southwest quadrants, notably Columbus Avenue, Tremont Street, and the Southeast Expressway. Therefore, it appears reasonable that traffic on Clarendon Street, south of Stuart Street and Columbus Avenue is greater than to the north.

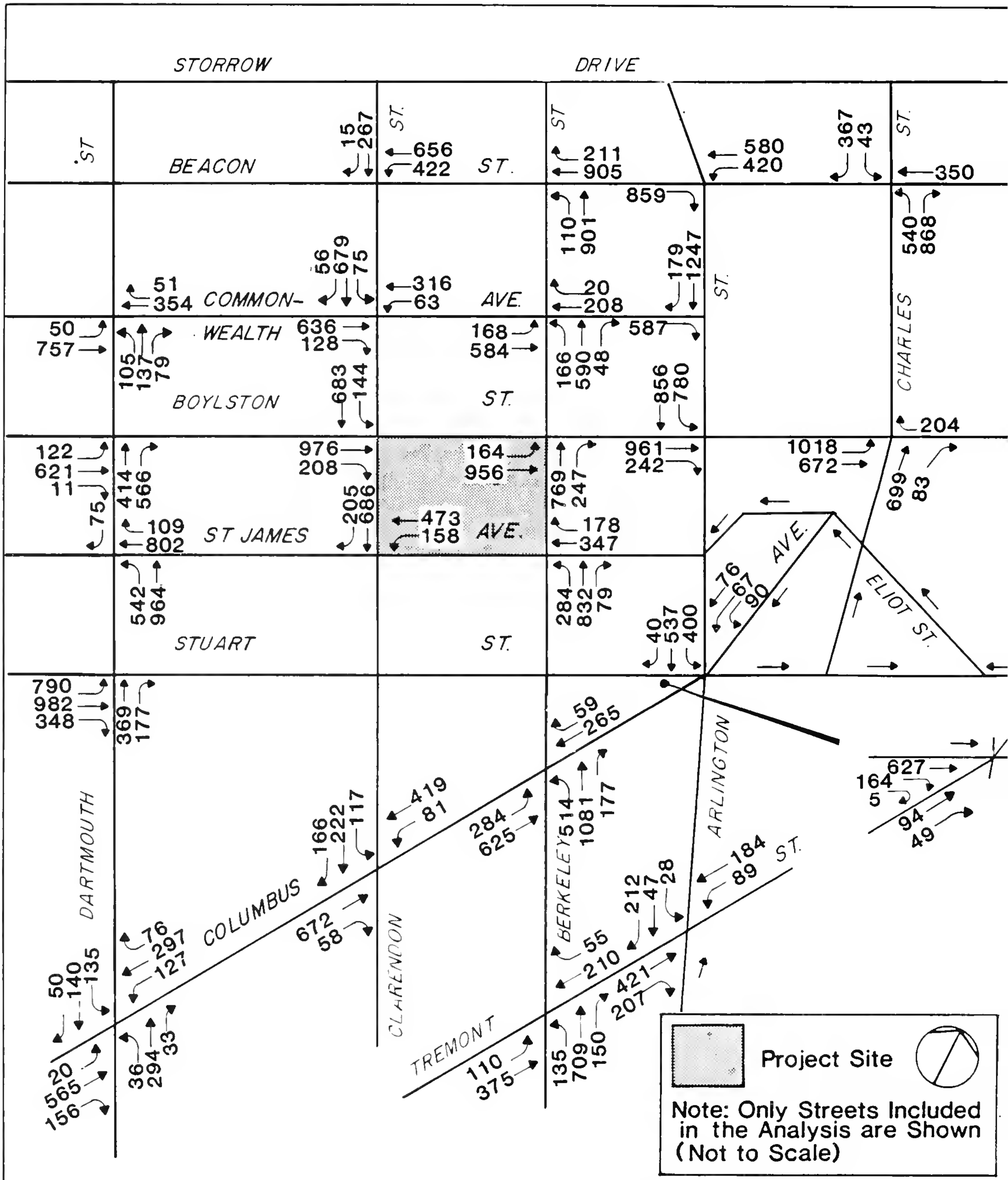
COMMENT 25: The traffic network maps are misleading in showing Columbus Avenue linking with Charles and Boylston. This should be corrected.

RESPONSE: The traffic network maps are in schematic form for presentation of turning movement count data. Actual operation of the street system is shown on Figure IV-3 of the Draft EIR in terms of street layout and circulation. A revised version of Figure IV-5 of the Draft EIR follows (presented as Exhibit IV-8) and shows additional detail in the Park Plaza area to assist in interpreting these diagrams.

COMMENT 26: The Final EIR should discuss the consistency of this project with the management of the Boston Parking Freeze.

RESPONSE: The 625 public spaces which are being provided (see response to Comment 16) are replacement spaces for the

Existing AM Peak Hour Volumes 1/



1/ This exhibit is a Revision of Figure IV-5, BRA Draft EIR, p. 33.

existing St. James Garage on the project site and do not change the number of spaces in the freeze "bank." The remaining 375 tenant spaces, which are classified as non-commercial parking, are exempted by definition from the application of the parking freeze regulations.

COMMENT 29[1]:

[Ref. Appendix 2: Transportation, BRA Draft EIR] Why are different time periods used for the AM and PM peak hour counts, rather than all being the same (e.g. 8:00-9:00 AM, rather than some 8:00-9:00, some 8:30-9:30, etc.)?

RESPONSE:

A system peak hour was not used. Rather, each location was analyzed as an independent intersection during its own particular peak hour (highest four consecutive 15-minute count periods). Not all intersections peak at the same time, so this represented a more conservative approach.

COMMENT 30:

[Ref. Appendix 2: Transportation, BRA Draft EIR] The Beacon/Charles and Beacon/Arlington intersection analyses do not seem to include a pedestrian phase. This may be true at other intersections as well. Since this in an important impact in both LOS and the air quality analyses, the omission is questionable.

RESPONSE:

As indicated in the response to Comment 11, an extra pedestrian phase was included where more intense pedestrian activity is prevalent (e.g., Boylston and Dartmouth Streets). At other locations, normal TRC 212 analysis procedures were applied. However, further field observation has indicated that a 16-second all-pedestrian phase is built into the signal system at Beacon/Charles, reducing available green time at the 80-second cycle by 20 percent during every cycle. Therefore, adjustments were made to the analysis at this location by reducing the level of service criteria by 20 percent and recalculating the V/C ratios. The results are shown below:

1/ The BRA's Comments 27 and 28 refer to issues raised in the Air Quality section [pp. 103-119] of the BRA Draft EIR, and therefore have been responded to in the Air Quality subsection of this BRA Final EIR.

	Existing		1989 No-Build		1989 Build	
	V/C	LOS	V/C	LOS	V/C	LOS
AM Peak	0.76	C	0.77	C	0.77	C
PM Peak	0.80	C/D	0.80	C/D	0.80	C/D

The new results are still within the range of acceptable traffic operation and have no effect on the BRA Draft EIR's conclusions and recommendations.

COMMENT 32<u>1</u>/: The intersection of Clarendon and Tremont is covered in the air quality analysis but not in the traffic analysis. In view of the strong community interest of this location, it should be added to the traffic analysis section of the Final EIR.

RESPONSE: Unlike all other locations analyzed in the BRA Draft EIR, the Clarendon/Tremont intersection is unsignalized and, therefore, requires a different analysis technique. Based on TRC 212, capacity calculations for an unsignalized intersection assume that the major street traffic is not affected by the minor street movements. The capacity of the intersection is a function of: the right turns into the major road; the left turns from the major road; through traffic crossing the major road; left turns into the major road; and the number of acceptable gaps in the through traffic streams which allow turning or crossing vehicles to pass through the intersection. The critical acceptable gap is defined as "that gap for which an equal number of drivers will accept a shorter gap as will reject a longer gap." Based on a gap acceptance function, the capacity of the minor approach can be determined. The difference between available capacity and existing demand is defined as "reserve capacity" and is used as the criterion for determining level of service. Exhibit IV-9 summarizes the relationship between level of service, reserve capacity, and expected traffic delay.

1/ Comment 32 was grouped under the subheading of Air Quality in the BRA's list of comments but because it refers to an issue applicable to the traffic analysis it is responded to in this Transportation section of the BRA Final EIR also.

EXHIBIT IV-9
LEVEL OF SERVICE AND EXPECTED
DELAY FOR RESERVE CAPACITY RANGES1/

Reserve Capacity	Level of Service	Expected Traffic Delay
400 or more	A	Little or no delay
300 to 399	B	Short traffic delays
200 to 299	C	Average traffic delays
100 to 199	D	Long traffic delays
0 to 99	E	Very long traffic delays
Less than 0	E	Failure-extreme congestion
(Any value)	F	Intersection blocked by external causes

1/ Transportation Research Board, Transportation Research Circular Number 212. Interim Materials on Highway Capacity, Washington, D.C., January 1980.

The Clarendon/Tremont Street unsignalized intersection has been analyzed during the AM and PM peak hours, based on available traffic counts. The results in terms of Reserve Capacity (RC) and levels of service are indicated below:

	Existing		1989 No-Build		1989 Build	
	RC	LOS	RC	LOS	RC	LOS
AM Peak	487	A	487	A	487	A
PM Peak	251	C	251	C	251	C

Traffic count summary and analysis sheets are presented in Appendix 2 at the end of this Final EIR for the existing case only since the volumes are the same for the 1989 no-build and build cases (intersection volumes increase, but not critical lane volumes).

COMMENT 61[1]:	[Ref. Table IV-3, BRA Draft EIR] Boylston Street P.M. peak volume should be 1,150, not 1,160 (see Fig. IV-6).
RESPONSE:	The correction is noted.
COMMENT 62[1]:	[Ref. Figure IV-3, BRA Draft EIR] The arrow on Marlborough Street (between Arlington and Berkeley) should be reversed (the street is one-way westbound for this block).
RESPONSE:	The correction is noted.
COMMENT 63[1]:	[Ref. Fig. IV-7, BRA Draft EIR] The Copley Place parking numbers are not correct. There are 275 spaces at the Westin Hotel (not 1,157 as shown) and 860 in the Copley Place parking garage across Stuart Street.
RESPONSE:	The 1982 BRA Parking Inventory indicated a total of 1,157 parking spaces for Map Code 276B - Copley Place and Marriott Hotel. The revised figure of 1,135 spaces resulting from 275 at the Westin Hotel and 860 at the Copley Place garage is noted. This small variation has virtually no affect on any of the analyses.
COMMENT 64[1]:	[Ref. Table IV-3, BRA Draft EIR]. Indicate the date of these statistics.
RESPONSE:	Two sets of MBTA data were available, one for 1983 and another for 1984. The higher of the two for each branch line was used. Therefore, the applicable dates for the PM peak hour vehicle and ridership data are as follows:

1/ Comments 61-64 were grouped at the end of the BRA comments under the subheading Miscellaneous Corrections/Comments. However, since they are all directly applicable to the transportation analysis, they are answered in this Transportation section of the Final EIR.

- o Inbound, "B" and "E" Branches: January 10, 1983
- o Inbound, "C" and "D" Branches: January 19, 1984
- o Outbound, All Branches: January 11, 1983.
- o The number of scheduled vehicles was obtained from the MBTA for estimating PM peak hour capacities. They were the same for 1983 and 1984.

Air Quality

INTRODUCTION

An air quality analysis was performed for the BRA Draft EIR to determine whether the proposed 500 Boylston Street Project would affect the attainment or maintenance of the National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO), established by the Federal Clean Air Act. Using air quality modeling techniques, CO levels were estimated at 12 sensitive receptors for the build and no-build alternatives under existing and future (1989) conditions. The 12 sensitive receptors were intersections near the site. Nine of these intersections were chosen because their level of service during the AM or PM peak hour in the 1989 build case was below C according to the transportation analysis. The remaining three intersections were selected by the Massachusetts Department of Environmental Quality Engineering (DEQE) as appropriate due to their proximity to the South End residential district. The pollutant levels--predicted using the EPA Indirect Source Guideline model and a set of assumptions specified by DEQE--were compared to the NAAQS and the results reported in the BRA Draft EIR, with supporting technical data presented in Technical Appendix 3 on Air Quality. The comments from the BRA responded to in this Final EIR requested clarification of certain aspects of the air quality analysis as presented in the Draft EIR.

COMMENT 31:

[Ref. Table IV-35, p. 11, BRA Draft EIR]
The air quality analysis indicates an 8-hour violation (1989 Build) at the Berkeley/Columbus intersection, but the Intersection LOS analysis (Table IV-24) predicts a LOS of A at the same intersection. This would appear to be contradictory. Are the contributions from the Turnpike included? An explanation should be provided in the Final EIR.

RESPONSE:

The results cited are not contradictory. While the PM peak level of service (LOS) is A for the Berkeley/Columbus intersection, the AM peak is D for this intersection, as shown in Table IV-23 of the BRA Draft EIR. The violation predicted occurs during the peak eight-hour period in the middle of the day, and does not correspond to just the AM or PM peak hours.

Contributions from the Massachusetts Turnpike to CO concentrations are represented in the urban background levels used in the air quality analysis.

COMMENT 32:

The intersection of Clarendon and Tremont is covered in the air quality analysis but not in the traffic analysis. In view of the strong community interest of this location it should be added to the traffic analysis section of the Final EIR.

RESPONSE:

An air quality study of this intersection was requested only by the Department of Environmental Quality Engineering, which did not indicate a need for a full transportation analysis of this intersection. The air quality results show this intersection to have CO concentrations far below the NAAQS, reflecting that relatively little traffic congestion is present (see Exhibit IV-10). However, a traffic analysis has been conducted and is presented in the Transportation section under Comment 32, which is repeated.

COMMENT 33:

[Ref. pp. 112 and 118-9, BRA Draft EIR]
What is the commitment to the mitigation measures outlined to reduce CO levels?

RESPONSE:

The three measures proposed in the BRA Draft EIR to mitigate CO violations were: (i) removal of on-street parking from the west side of Arlington Street between St. James Avenue and Columbus Avenue, (ii) balancing of the off-peak dial of the traffic signals at Berkeley/Boylston, Berkeley/St. James, and Berkeley/Columbus, and (iii) continuation of the State Inspection and Maintenance Program (see Comment 36 also). While the proponent supports these measures, all fall under the jurisdiction of the City or State, which would be responsible for their implementation.

Parking is currently prohibited in the area for the AM and PM peak hours to increase roadway capacity. By 1989 the air quality analysis indicates that an extension of this ban between the AM and PM peak hours will be needed to avoid air quality problems. The commitment to remove on-street parking from the west side of Arlington Street must be made by the City of Boston, which oversees parking policy.

The balancing of traffic signals at the three intersections along Berkeley Street is scheduled to occur by 1989 under the Boston Traffic and Parking Department's

EXHIBIT IV-10

Predicted Maximum CO Concentrations (PPM), Plus Background, at 12 Project Area Intersections 1/2/3/4/

Intersection Receptor	1984 Existing (Case 1) 1-hour	1984 Existing (Case 1) 8-hour	1989 No-Build (Case 2) 1-hour	1989 No-Build (Case 2) 8-hour	1989 Build (Case 3) 1-hour	1989 Build (Case 3) 8-hour
Arlington/Columbus	33.0	13.7	24.8	8.9	25.9	9.4
Arlington/Tremont	22.6	9.5	13.6	6.1	14.5	6.4
Berkeley/Beacon	42.9	13.5	24.2	8.1	24.4	8.2
Berkeley/Commonwealth	28.7	13.1	20.7	6.7	23.3	7.4
Berkeley/Boylston	38.4	13.0	24.7	8.7	29.1 2/	9.9 2/
Berkeley/St. James	37.7	13.9	22.3	9.0	23.7 2/	9.5 2/
Berkeley/Columbus	49.6	18.0	26.7	10.4	29.8	11.4
Clarendon/Boylston	24.1	9.2	15.6	6.4	19.9 2/	7.6 2/
Clarendon/Tremont	15.0	6.5	15.4	6.3	15.6	6.3
Dartmouth/St. James	29.8	10.9	20.9	7.9	21.9	8.5
Dartmouth/Columbus	23.3	8.2	21.0	5.7	22.0 3/	5.9 3/
Dartmouth/Tremont	26.7	10.4	14.8	6.2	15.7	6.5

1/ The CO standards set a maximum concentration of 35 parts per million (ppm) for a 1-hour period and 9 ppm for 8 hours, each not to be exceeded more than once per year. Concentrations in excess of the standards are underlined.

2/ This exhibit originally appeared as Figure IV-35, BRA Draft EIR, p. 111.

3/ Includes the impact of the ventilation air from the 500 Boylston Street parking garage.

4/ Includes the impact of the ventilation air from the National Garage.

Signal Improvement Project as discussed under Transportation in the BRA Draft EIR, p. 45.

It is assumed that the Commonwealth of Massachusetts will maintain its commitment to the Inspection and Maintenance Program for motor vehicles.

COMMENT 34:

[Ref. Asbestos p. 117, BRA Draft EIR]
EPA regulations regarding asbestos removal also must be met and should be referenced here.

RESPONSE:

If asbestos is found on site, DEQE, EPA, and all other appropriate agencies will be notified and a removal plan will be formulated that complies with Massachusetts Air Pollution Control Regulation 7.15 and all other applicable state and federal regulations.

COMMENT 35:

[Ref. Construction Impacts, Air Quality, BRA Draft EIR]
The dust emission factor does not account for building demolition impacts; this also should be evaluated.

RESPONSE:

EPA's standard publication of emission factors (AP-42) does not provide any separate estimate of fugitive dust impacts from building demolition. Rather, all aspects of construction, including "land clearing" and "blasting" are included in the heavy construction operations emission factor that was used in the BRA Draft EIR.

COMMENT 36:

[Ref. p. 118, BRA Draft EIR]
Since the Inspection and Maintenance Program is in operation, it cannot be included as a mitigation measure to reduce CO emissions.

RESPONSE:

The Inspection and Maintenance Program was mentioned under Mitigation Measures in the Draft EIR section on Air Quality to call attention to the fact that its continued operation is assumed in the analysis of 1989 air quality impacts.

COMMENT 37: [Technical Appendix 3, Air Quality, BRA Draft EIR] The traffic ratios in Figure 1 do not appear to be supported by the data presented in the Transportation Appendix. Also, the 8-hour results (Table IV-35 of the EIR) appear to be rather low compared to the 1-hour results. All appear to be below the urban persistence factor (ratio of eight-hour to one-hour CO concentration) of 0.6 to 0.7, which is the general guidance of the EPA. This discrepancy should be investigated and thoroughly discussed, and any necessary changes made.

RESPONSE: The eight-hour traffic volume factors used in the air quality analysis do not relate to data in the Transportation Appendix because transportation uses only peak one-hour traffic, while air quality is concerned with peak eight-hour traffic. The factors shown in Figure 1 of the Air Appendix were provided by Vanasse/Hangen Associates, Inc. and are based on the ratios of traffic counts taken during the peak one-hour and eight-hour periods in the Back Bay. Eight-hour traffic volume factors in Boston are typically below 0.80 (the ratio of the average hourly volume of the peak eight-hour period to the one-hour volume). The fact that values equal to or exceeding 0.80 were used on all but one roadway is an indication that fairly high levels of traffic persist in the Back Bay throughout the day.

The persistence factor of 0.6 to 0.7, which usually relates measured one-hour and eight-hour CO concentrations, does not apply to this analysis because the values predicted are not typical air pollution levels that could be measured in the project area. Rather, they represent the highest concentrations that might result if several worst case events occurred simultaneously. The conservatism in these results is probably greatest for the one-hour concentrations, which if overestimated will make the eight-hour concentrations appear to be low. The gap between one-hour and eight-hour levels is caused by the following assumptions which DEQE required in this analysis:

1) One-hour wind speeds are lower than eight-hour wind speeds (p. 1, BRA Draft EIR Technical Appendix 3: Air Quality), and as a result one-hour concentrations are 60 percent higher due to just this assumption.

2) One-hour cold start vehicles are assumed to be over twice as numerous as eight-hour cold start vehicles (p. 12, BRA Draft EIR Technical Appendix 3: Air Quality), and as a result one-hour concentrations are 40 percent higher due to just this assumption.

COMMENT 38:

[Technical Appendix 3, Air Quality, BRA Draft EIR] In addition, the V/C ratios used in this air quality study (demand volume on line 2 of worksheet 2 divided by the capacity on line 6.7, and the results summed) and in the traffic study do not appear to coincide in all cases, even approximately. (As an example for 1989 Build case, Clarendon and Boylston, the air quality V/C is 1.28 whereas the traffic V/C is 0.67.) There should be consistency between both studies, especially since the traffic analysis includes the effect of pedestrians on intersection operations, an effect not explicitly accounted for in Worksheet 2. This discrepency should be discussed and any necessary revisions made.

RESPONSE:

The vehicle-to-capacity (V/C) ratio for Boylston Street at Clarendon Street (peak one-hour, 1989 build case) used in the Air Quality analysis is 1418/2184 = 0.65, a value quite close to that used in the Transportation analysis. Nowhere in the Air Quality analysis did this ratio ever equal or exceed 1.00. Differences between the V/C ratios used in the Transportation and Air Quality sections are unavoidable. The same traffic volumes were used in each case, but the capacity figures will differ because DEQE requires that capacity be calculated using the nomographs in EPA's Indirect Source Guideline (taken from the 1965 Highway Capacity Manual) while the Transportation analysis usually employs more recent techniques for estimating capacity.

COMMENT 27 1/:

If off-street [on-street, ed.] parking is removed from Arlington Street as a mitigation measure, what assumptions have been made regarding how the demand will be met?

1/ Comments 27 and 28 are grouped under the heading Transportation in the BRA's List of Comments. However, both comments refer to points raised in the Air Quality section of the Draft EIR and are, therefore, responded to here under Air Quality.

RESPONSE: The parking ban mitigation measure proposed was for the west side of Arlington Street between St. James Avenue and Columbus Avenue. This one block has less than a dozen parking spaces and these service high-turnover shopper demand, not commuters. As noted in the transportation analysis in the BRA Draft EIR, the parking system in the area will be at capacity in 1989 with the project. Therefore, removal of these spaces will cause a small shift in travel characteristics, namely either an increase in vehicle occupancy rates or a decrease in arrivals by auto for retail shopping during the middle of the day.

COMMENT 28[1/]: Do the results from the receptors modeled in Tables IV-37 and IV-38 include impacts from the adjacent intersections that were also modeled?

RESPONSE: The parking garage receptor results do not include impacts from adjacent intersections. However, the maximum garage impacts were added into the maximum intersection impacts for all nearby intersections in Table IV-35 of the Draft EIR (presented in this Final EIR as Exhibit IV-10). Thus, the air quality analysis did consider the cumulative impact of the highest concentrations from both the intersections and the garages.

1/ Comments 27 and 28 are grouped under the heading Transportation in the BRA's List of Comments. However, both comments refer to points raised in the Air Quality section of the Draft EIR and are, therefore, responded to here under Air Quality.

Natural Resources

INTRODUCTION

Extensive analysis has been ongoing to evaluate the potential effects of the project's construction on surrounding structures and groundwater levels. This effort, which has drawn on 50 years of subsoil and groundwater studies in the Back Bay, has resulted in the foundation design and construction recommendations reported in the BRA Draft EIR. Use of these specified approaches and techniques, supplemented by a detailed monitoring and mitigation plan, will prevent adverse groundwater movement and control groundwater levels. This is elaborated upon further in the responses to the BRA's comments below.

COMMENT 39:

[Ref. pp. 143-144, BRA Draft EIR]
What is the basis for the minimal ground settlement conclusion? There apparently was a substantial settlement of part of Boylston Street during construction of the Four Seasons Hotel. Also, on page 144 it is stated that the maximum settlement around the John Hancock construction was 1.5 feet. However, an earlier Haley & Aldrich report presented to the BRA indicated a settlement of up to 3 feet in surrounding streets, twice the amount reported in the EIR. This should be clarified.

RESPONSE:

The basis for the ground settlement conclusions are described on pages 120 through 123 and 142 through 145 of the BRA Draft EIR. In summary, these conclusions are based on evaluations of anticipated excavation procedures, subsurface soil and groundwater conditions, and computer-aided modeling of the proposed excavation. Also, judgments about the anticipated performance of the excavation were compared with experience at previous excavations in the Back Bay and other areas of Boston, and excavations in other cities under similar soil conditions.

Adverse ground settlements have been documented at a few previous building excavations in Boston. However, most major building excavations in the City during the past 40 years have been conducted without significant adverse effects on nearby structures. The adverse movements which have been documented can be attributed to inappropriate construction procedures such as pulling of timber piles without proper backfilling of the resulting holes, excessive reliance on earth berms to restrain the lateral earth support system, and other

unsatisfactory procedures. Such inappropriate procedures will be specifically prohibited in the contract specifications for the proposed project. Extensive pre-planning and development of mitigation measures is being undertaken for this project in recognition of the importance and special character of the nearby structures.

Additional discussions of previous excavation experience and procedures in Boston, and procedures proposed for the 500 Boylston Street Project, were included in a Haley & Aldrich report entitled "Preliminary Report on Geotechnical Aspects of Foundation Construction, Proposed NEML/Gerald D. Hines Development, Boylston and Clarendon Streets, Boston, Massachusetts." This report was prepared in May 1983, prior to the BRA Draft EIR, and distributed to the BRA and the St. James CAC.

In the second paragraph on page 144 of the BRA Draft EIR it is stated "Ground settlements up to 1.5 feet occurred at the <u>north</u> side of St. James Avenue (<u>side near to Trinity Church</u>) [emphasis added] as a result of the excavation." This is in reference to the excavation for the John Hancock Tower which was completed in 1969. In Appendix A of the aforementioned 1983 Haley & Aldrich report (John Hancock Tower-Project No. 3 in the Appendix), it is stated that "...streets settled up to 3 ft." These two referenced statements refer to settlements at different locations relative to the John Hancock Tower excavation. Three feet was the maximum street settlement that was observed and this maximum settlement occurred immediately adjacent to the excavation along Trinity Place, the abutting street to the west. Ground settlements across the streets from the excavation were smaller; on the order of 1.0 to 1.5 feet maximum along the north side of St. James Avenue.

COMMENT 40:

[Ref. pp. 149-151, BRA Draft EIR]
The construction monitoring systems and other mitigation measures need to be specified in greater detail in the final report. For example, the early warning capability needs to be described. There is considerable concern over the potential subsidence which could occur at Trinity Church, the Berkeley Building, and the St. James Sewer, and assurances are needed

that appropriate mitigation measures will be followed to reduce potential subsidence to acceptable levels.

RESPONSE:

As reported in the Draft EIR, requirements for monitoring the performance of the excavation and for preparing appropriate mitigation procedures will be contained in the project specifications. Monitoring will include settlement and offset surveying of the lateral earth support system. This monitoring will enable early detection of movements of the earth support system, and thus provide advance warning of ground movements outside the excavation. It will also enable measurement of relatively small movements of the system so that mitigation measures can be implemented before larger movements can occur.

In addition, measurements of ground settlement and lateral ground movement outside the excavation will be monitored with surface and deep settlement points and with inclinometers. These measurements will be performed at selected intervals around the excavation, at surrounding streets, and at nearby structures. Elevation reference points have already been established on nearby buildings, including Trinity Church, and will be monitored closely throughout project construction. This monitoring will be done at a frequency that is consistent with the construction activities at the site. At locations near ongoing excavation, earth support system installation, or similar activities, monitoring will occur daily unless another frequency is appropriate based on previous observations or measurements.

The project proponent and the contractor will be monitoring the instrumentation devices and will be in round-the-clock communication to enable rapid response to any need for mitigation measures. In addition, the project proponent has agreed to provide funding for the BRA to engage a geotechnical consultant to monitor the impact of the project construction. The BRA consultant will be provided the instrumentation data collected by the proponent.

Other, more specific mitigation measures will be developed after the lateral earth support system is designed, prior to beginning the excavation. Such mitigation measures could include increasing the number of levels of internal bracing, providing additional

and/or stiffer internal bracing members, reducing the depth of excavation for each bracing level, placing temporary earth fill against the system, and modifying the sequence of excavation areas within the site. The contractor will be required to maintain sufficient on-site equipment and materials to implement the mitigation measures.

The proponent's geotechnical engineer will be monitoring the performance of the contractor and the excavation continuously. Provisions will be made to halt work promptly and implement all necessary mitigation measures in the event that adverse ground or system movements are detected.

COMMENT 41:

[Ref. p. 150, BRA Draft EIR]
The MBTA should be consulted regarding potential impact on the Boylston Street subway tunnel.

RESPONSE:

The Engineering Department of the MBTA was notified of the features of the subject project, especially relating to excavation, lateral earth support systems, and building foundation construction in the vicinity of Boylston Street. A copy of the BRA Draft EIR has been reviewed by the MBTA engineering department. The MBTA has indicated to the proponent that it has no specific concern with the proposed construction, as related to any possible effects on the subway tunnel beneath Boylston Street. The MBTA has requested to be provided with copies of the final drawings and specifications, as well as contractors' submittals, pertaining to the foundation construction along Boylston Street as such documents become available. This information will be provided to the MBTA as requested.

COMMENT 42:

If additional connections are made to the St. James Avenue sewer, the impact on the watertable in the vicinity of St. James Avenue should be discussed.

RESPONSE:

Connections to the 30-inch diameter sanitary sewer pipe under St. James Avenue (St. James sewer) will be constructed for the proposed project. The connections will require trenching from the site limits to the pipe, approximately half way across the street.

Trenching procedures will be similar to those used routinely for such work and will consist of:

a) Installing continuous sheeting (probably interlocking steel sheet piling) into the organic silt stratum below the bottom of the trench. The sheeting serves to support the side walls as well as act as a seepage cutoff to limit groundwater infiltration into the trench.

b) Excavating within the sheeting to the required depth, placing internal bracing to support the sheeting.

c) Dewatering from inside the trench, as necessary, to maintain a stable bottom and enable work in the dry.

d) Installing the pipe and making the required connections.

e) Backfilling the trench, and removing sheeting where possible.

Some temporary lowering of the water table adjacent to the trench will occur during this work. However, since the sheeting will penetrate into the relatively low-permeability organic silt below the fill, it will help cut off the groundwater and reduce the temporary drawdown. For trenches down to the level of the sewer pipe, the maximum water table drawdown will likely be about 5 feet very close to the trench, decreasing to zero drawdown within a short distance (probably less than about 50 feet from the trench). Since the sewer tie-ins are planned to be located at least 100 feet east of Clarendon Street, the temporary drawdown is not expected to reach the Trinity Church area. After dewatering is terminated, the groundwater will return to its normal levels within a few days. No permanent adverse effect on the water table is anticipated.

Such temporary, local drawdown is common for utility excavations below the water table in Boston. Due to its limited areal extent and duration, it is not expected to adversely affect the street, the sewer, or other nearby underground facilities. Similarly, no adverse effects on nearby buildings are expected due to the local, temporary dewatering.

COMMENT 43: The impact of projected subsidence of soil under St. James Avenue on possible additional sewer connection openings should also be considered.

RESPONSE: The natural resources analysis prepared for the BRA Draft EIR predicted less than two inches of settlement for the St. James Avenue sewer at the center of the block between Berkeley and Clarendon Streets. As reported in the Draft EIR, movements that could be experienced by the sewers in the project vicinity would primarily be a result of movements in the bracing systems to be used to support the sides of the excavation.

That portion of the St. James Avenue sewer that lies within the project area is an unreinforced concrete encased tile sewer constructed in the early 1900s. Given the sewer's construction and the age, it is considered sensitive to settlement. It is, however, extremely difficult to project the potential damage that might result from the predicted maximum settlement of two inches. Therefore, in addition to specifying construction techniques to minimize ground movement, the construction monitoring plan, discussed in the response to Comment 40, will include ongoing monitoring of groundwater levels and soil movement in the project area during construction. Surface and deep-seated settlement test points and inclinometers in the St. James area will be used to detect soil settlement and movement, allowing early response by the proponent with additional mitigation measures as appropriate. If damage or functional disruption of the sewer line should result from the excavation and construction of the 500 Boylston Street Project, the proponent will take responsibility for the appropriate repairs.

INTRODUCTION

The BRA Draft EIR described in text and through the use of computer-generated drawings how the proposed project would relate to the historic, visual, and urban design qualities of the neighboring districts and buildings. Proposed schematic designs for the project have been reviewed throughout the evolution of the planning process by the BRA and the St. James Civic Advisory Committee. These reviews led to modifications in the height of the office towers, the distance between the two towers, and the building set backs, which were reflected in the Draft EIR.

COMMENT 44:

More explanation is needed as to how the two towers relate to the historic scale and character of the Back Bay.

RESPONSE:

The project site is located in a transitional zone between two very different but important parts of the Back Bay: the Back Bay Historic District and the southern portion of the Back Bay characterized by a spine of large-scale office buildings. The 500 Boylston Street project incorporates elements of both areas and scales in its design--from the lower scale, active retail/office uses characteristic of Boylston Street to the office towers along St. James Avenue.

At a height of six stories, the lower portion of the proposed development fronting on Boylston Street is located in the Back Bay Historic District (see Exhibit IV-11). This portion respects the heights, material, and detailing of neighboring historic buildings and maintains the scale of existing buildings on the site. As such the design clearly relates to the historic context of Boylston Street rather than to the newer office buildings on the north side of Boylston Street, which exceed the proposed six-story element by as much as 65 feet.

The proposed office towers are sited south of Providence Street on that portion of the site that lies outside of the Back Bay Historic District. The towers are consistent with the concept of a spine of high-rise buildings south of Boylston Street along the mass transit line, as recommended in 1961 by the Boston Society of Architects. The "high spine" concept was created to allow intensive development in one area of the Back Bay while allowing the restoration and

preservation of the residential character in other parts of the Back Bay. This concept appears to have been founded on an historic trend of commercial development in the southern area during the 20th century that began with the construction of the Statler Hotel (now the Park Plaza) and nearby office buildings, including the Berkeley and Clarendon Hancock Buildings. The construction of the Prudential Center and the new John Hancock Tower in the mid-1900s actively reinforced the "high spine" concept.

The proposed towers are set back approximately 145 feet from the Boylston Street curb to minimize visual impacts to the Back Bay, particularly Trinity Church, Bonwit Teller, and the Berkeley Building (Decorators' Building). As noted in the BRA Draft EIR, the 500 Boylston Street towers are designed to be a modern structure whose textures, materials, architectural elements and details are compatible with the architectural styles of surrounding properties.

The development of paired towers in the Back Bay has occurred at least twice in recent years. The new Ritz Carlton hotel reflects the height, massing, and materials of the adjacent original building in a modern structure. At Copley Place, the Westin and Marriott hotel towers are constructed of similar materials, with slightly different heights and massing with a greater building spacing than will occur at 500 Boylston Street.

Historic structures are an element of the character of the project area, and some views to existing structures will be affected by the proposed development:

- From the south side of St. James Avenue east of the site, views of Trinity Church will be interrupted by the project. From the north side of Park Square, views of Trinity Church (along Providence Street) will also be interrupted by the project. These effects would be likely to occur with any full-block redevelopment of the site at the permitted FAR. The semi-circular recesses at the corners of the project's six-story base increase the site lines to historic structures as compared to square-form corners.

- The backdrop to views to the Trinity Church spire from the east steps of the Boston Public Library

(pp. 182-183 in the BRA Draft EIR) becomes building rather than sky. These effects would be likely to occur with any full-block redevelopment of the site at the permitted FAR. As noted in the BRA Draft EIR, the inclusion of design elements and the selection of building materials for the towers that are compatible with the church help to mitigate this effect.

- Views to the old Hancock Tower from the Back Bay and elsewhere in the Boston area will be partially obstructed by the proposed towers (see pp. 167, 173, 181 of the BRA Draft EIR). Through the planning and development process, the reduction in height and increased spacing of 60 feet between the towers helped to mitigate this effect.

The office tower portion of the 500 Boylston Street Project--through decisions as to its location, massing, and detailing--has been designed to be generally consistent with the diverse character and scale of its Back Bay site.

COMMENT 65 1/:

[Ref. Figure IV-29, BRA Draft EIR]
The Back Bay and South End historic districts boundaries should be added to the figure (also stated in the text on pg. 154).

RESPONSE:

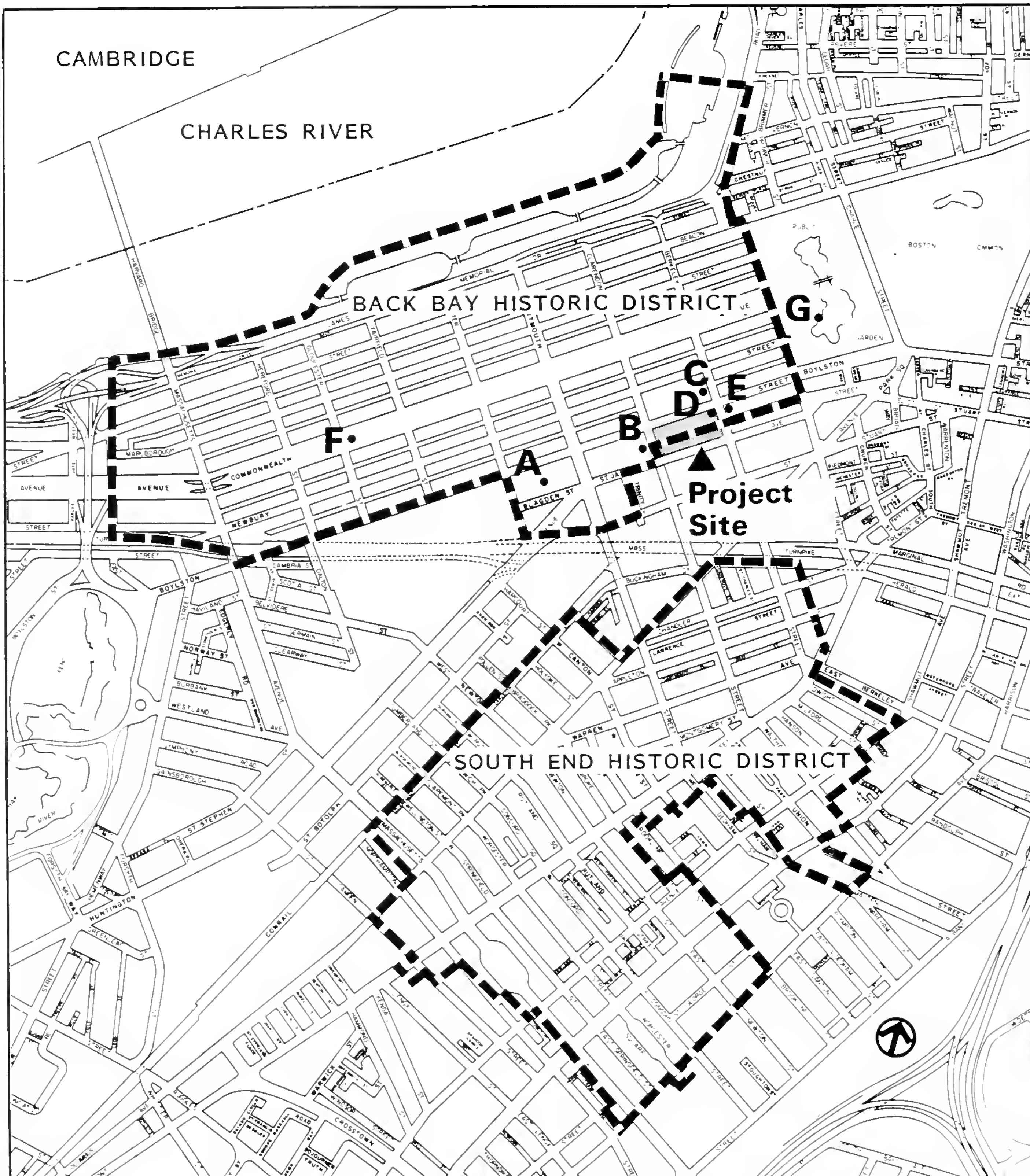
The boundaries for the Back Bay and South End Historic Districts have been clarified and the revised figure is presented in this BRA Final EIR as Exhibit IV-11.

For textual purposes, the Back Bay Historic District boundaries are described in the State Register of Historic Places, July 1984, as "Commonwealth Avenue, from Arlington Street to Charlesgate East." More specific boundaries are included in the National Register of Historic Places Inventory-Nomination Form

---

1/ Comment 65 was grouped at the end of the BRA comments under the subheading Miscellaneous Corrections/Comments. However, because it was directly applicable to the Historic/Visual Quality analysis, it is answered in the Historic subsection of this Final EIR.

Site Historic Context



A Boston Public Library, B Trinity Church, C Bonwit Teller Building, D Colton Building, E Berkeley Building, F Commonwealth Avenue Mall, G Public Garden

for the Back Bay Historic District and were used as the guide for the boundaries presented in Exhibit IV-11. The South End Historic District is described in the State Register of Historic Places, July 1984, as the "South Bay Area between Huntington & Harrison Avenue." A map of the South End Historic District, included in the National Register of Historic Places Inventory Nomination Form was used to verify the boundaries shown in Exhibit IV-11.

Wind

INTRODUCTION

To assess the possible wind effects of the proposed 500 Boylston Street development on the ground-level pedestrian environment in and around the project site, two types of tests were conducted at the Wright Brothers Memorial Wind Tunnel (WBWT) at MIT. The initial wind analysis conducted by WBWT was based upon an evaluation of data collected from a wind erosion test in February 1983. In May 1984, a second test using the hot-wire anemometer method was performed as required by the scope for the BRA Draft EIR. The BRA Draft EIR described the hot-wire test methodology and the evaluation of test results for both the existing and proposed site conditions. A more detailed presentation of hot-wire wind tunnel testing methodology and data evaluation was included in the BRA Draft EIR Technical Appendix on Wind. Comments made in reference to the BRA Draft EIR text and the accompanying Technical Appendix are presented and responded to in this BRA Final EIR.

In December 1984, subsequent to the submission of the BRA Draft EIR, additional hot-wire wind tunnel tests were conducted at WBWT. These tests were conducted to evaluate pedestrian-level wind conditions under two circumstances: a revision of the project design, and the implementation of mitigation measures. The revised project design in the model consisted of the widening of the tower separation to 60 feet, a change in the tower floor plate dimensions from 110 feet by 207 feet, to 107 feet by 212 feet, and the widening of the sidewalk along Berkeley Street by four feet to 19 1/2 feet. The mitigation measures tested included three configurations of tree plantings designed to moderate adverse wind conditions created by the proposed development in the presently windy area near Trinity Church and the John Hancock Tower.

The results of the December 1984 hot-wire test are presented in this BRA Final EIR as applicable to the comments raised concerning the earlier wind studies presented in the BRA Draft EIR. A further description of the December 1984 hot-wire wind tunnel test methodology and data analysis can be found in Technical Appendix 3 on Wind, which accompanies this BRA Final EIR. The results of the December 1984 tests indicate:

- o Overall pedestrian-level wind speeds--as measured by the average difference in speed for three wind velocity types--are slightly reduced in and around the project site (see Comments 46 and 48).

- No additional test stations experience wind conditions exceeding the BRA Guideline for acceptability.

- The tested mitigation measures significantly improve the windiest pedestrian-level conditions currently experienced in the area near Trinity Church (see Comment 49); with tree configuration #1 no station will exceed the BRA Guideline defined as effective gust speeds of 31 mph, no greater than one percent of the time (speeds in excess of 31 mph are acceptable if they are the same or lower than existing conditions).

The proponent is in the process of planning an implementation strategy for the landscaping measures shown by the tests to be effective mitigation measures.

COMMENT 45:

[Ref. p. 186, BRA Draft EIR]
Previous wind studies did not show a net reduction in pedestrian level winds. Rather, of the 327 station conditions tested, 74 showed higher winds with the project than existing conditions, some of the increases being considered significant.

RESPONSE:

The first wind tunnel test conducted for this project--a wind erosion study--demonstrated that replacing the existing buildings on the site with the proposed 500 Boylston Street development would result in a net reduction of pedestrian-level winds. A 1:600 scale model of the project site and the surrounding area was placed in a wind tunnel that simulated the wind flow of the surrounding urban terrain of building heights and density. A single, particle thick layer of ricelike particles was placed on all pedestrian areas in the model. Then the test wind speed was increased from 0 to 40 mph in 5 mph intervals. At each speed increment, the adjusted distribution of particles was recorded photographically.

Specific readings were taken for 109 test stations in and around the site. Each of the 109 stations was tested for three conditions--summer, winter, and storm--and 12 wind directions. The data were evaluated for 327 station conditions consisting of the three test conditions at each of 109 stations. While 75 station conditions showed higher winds with the project in

place than under existing conditions, 38 station conditions remained unchanged, and 190 station conditions showed a reduction in pedestrian-level winds with the project in place. (Twenty-four station conditions did not exist prior to inclusion of the project and could not be compared to existing conditions.)

To compare the existing and proposed conditions, a scoring standard was applied to the wind erosion data for each station condition. For each station condition, under both existing and proposed conditions, the scoring standard assigned a relative score to the gradient velocity that cleared the rice particles under a given station condition, and then took weighted averages of the relative scores for each season.1/ In comparing existing to proposed conditions using the scoring standard, 111 station conditions experienced a significant reduction in windiness as demonstrated by a decrease in score greater than 0.5. In comparison, only 39 station conditions experienced a significant increase in windiness, as measured by an increase in score greater than 0.5. Therefore, "from an examination of all results of the [wind erosion] test,... replacing the existing building with the NEL complex in the model tested had the net effect of reducing the pedestrian level winds both in the near proximity and at reasonable distances away from the NEL complex." (A Wind Tunnel Study of Pedestrian Level Winds at the Proposed New England Life Building, WBWT-TR-1188, MIT, May 1983).

COMMENT 46:

[Ref. pp. 195-7, BRA Draft EIR]
While generally winds are either increased or decreased about 50/50 around the complex, winds are generally exacerbated around Trinity Church, the John Hancock Tower, along Clarendon Street, and to the east [west, ed.] of the project.

RESPONSE:

The hot-wire tests conducted in May 1984 compared existing conditions to project development for the BRA Draft EIR. According to these tests, the pedestrian-level winds around the proposed project will remain essentially unchanged (about the same number of stations experienced reduced velocities as those that

---

1/ Refer to p. 6-7, and Table 3, A Wind Tunnel Study of Pedestrian Level Winds at the Proposed New England Life Building, WBWT-TR-1188, MIT, May 1983.

experienced increased velocities), and in the area around Trinity Church, the John Hancock Tower, along Clarendon Street, and to the west of the project, winds are not generally exacerbated. (See Exhibits IV-12, 14, 15 and 16.) Of the 10 stations in this area (11, 12, 48, 52, 53, 59, 62, 66, 73 and 80), seven stations (11, 12, 52, 53, 62, 66, and 80) demonstrated reduced pedestrian-level wind speeds as measured by the average difference for the three velocity types: average velocity, effective gust velocity, and peak gust velocity. Three of those seven stations (11, 12, and 66) registered significant1/ reductions in pedestrian-level winds as measured by the average difference, although two stations (48 and 59) registered significant increases. Under proposed conditions three stations (48, 59, and 62) changed to a less acceptable Melbourne's criteria level than under existing conditions (the change at station 62 was due to an insignificant increase of 0.2 mph in average wind velocity), and stations 11 and 53 moved to a more acceptable criteria level. In addition, inclusion of the project development did not increase wind conditions at any stations to the extent that they exceeded the BRA Guideline.

With the revised project design in place the hot-wire tests conducted in December 1984 demonstrated that pedestrian-level wind conditions are generally improved around Trinity Church, the John Hancock Tower, along Clarendon Street, and to the west of the project. (See Exhibits IV-13-16.) Again, seven stations (11, 12, 48, 52, 53, 62, and 66) demonstrated reduced pedestrian-level wind speeds with the proposed project in place as measured by the average difference for the three wind velocity types. The average differences between pedestrian-level winds under existing as compared to proposed conditions showed significant reductions for stations 11 and 53. Winds at three stations (59, 73, and 80) demonstrated an increase in average difference, though none significantly. Two stations (11 and 53) moved to a more acceptable Melbourne's criteria level, and no stations moved to a less acceptable criteria level. As with the design tested for the BRA Draft EIR, no additional stations experienced wind conditions that exceed the BRA Guideline with the revised project design in place.

1/ As part of the experimental procedure and analysis of the hot-wire data, ±1.0 mph was assumed to be the significance level for changes in wind speed.

EXHIBIT IV-12

Comparison of Annual Velocities for the Project 1/

1% Predicted Average, Effective Gust, and Peak Gust Velocities (MPH)

	Area	Station Number	Average			Effective Gust			Peak Gust			Ave. Diff.
			Existing	Proposed	Diff.	Existing	Proposed	Diff.	Existing	Proposed	Diff.	
Ia	Sidewalks around complex	1	9.5	12.0	+2.5	16.2	18.8	+2.6	24.5	25.2	+0.7	+1.93
		3	10.8	14.8	+4.0	17.3	21.5	+4.2	24.2	29.5	+5.3	+4.50
		5	14.5	14.7	+0.2	21.6	22.1	+0.5	29.9	29.8	-0.1	+0.20
		7	18.6	16.6	-2.0	27.3*	23.6	-3.7	36.3	31.4	-4.9	-3.53
		9	15.0	15.4	+0.4	23.8	23.4	-0.4	33.3	31.4	-1.9	-0.63
		11	21.7*	12.9	-8.8	29.2*	19.8	-9.4	35.8	28.0	-7.8	-8.67
		12	19.8*	20.1*	+0.3	28.4*	26.1	-2.3	35.3	33.1	-2.2	-1.43
		14	10.6	16.5	+5.9	18.6	21.7	+3.1	25.6	27.4	+1.8	+3.60
		15	14.6	17.7	+3.1	19.6	23.6	+4.0	24.7	30.3	+5.6	+4.23
		17	19.8*	11.8	-8.0	24.2	16.9	-7.3	30.0	23.3	-6.7	-7.33
		19	16.3	10.9	-5.4	23.6	15.9	-7.7	23.3	21.9	-7.4	-6.83
Ib	Walkways inside complex	22	--	14.1	--	--	21.0	--	--	28.4	--	--
		24	9.1	9.1	0	15.2	14.7	-0.5	21.0	21.8	+0.8	+0.10
		26	--	12.9	--	--	19.7	--	--	28.1	--	--
		28	14.8	7.1	-7.7	21.2	12.3	-8.9	27.6	19.9	-7.7	-8.10
		110	--	15.2	--	--	21.2	--	--	29.5	--	--
		111	--	15.2	--	--	21.3	--	--	27.5	--	--
II	North East Block	31	17.7	17.6	-0.1	24.4	23.9	-0.5	33.5	31.5	-2.0	-0.87
		33	10.9	10.7	-0.2	18.4	17.7	-0.7	28.0	25.8	-2.2	-1.03
III	North Block (Existing NEL)	39	13.3	14.0	+0.7	21.2	21.9	+0.7	30.4	32.9	+2.5	+1.30
		43	10.6	9.1	-1.5	16.5	17.8	-1.7	24.2	23.9	-0.3	-1.10
IV	North West Block	48	18.9	21.2*	+2.3	26.6	28.7*	+2.1	33.3	36.6	+3.3	+2.57
V	West Block (Trinity Church) (Copley Park)	52	18.3	18.2	-0.1	25.6	25.0	-0.6	34.2	33.1	-1.1	-0.60
		53	19.1*	18.2	-0.9	25.6	25.4	-0.2	33.8	33.3	-0.5	-0.57
		59	23.9**	27.3**	+3.4	32.1**	35.2**	+3.1	39.0*	42.1*	+3.1	+3.20
		62	26.9**	27.1**	+0.2	33.9**	33.5**	-0.4	39.8*	39.0*	-0.8	-0.33
VI	South West Block (John Hancock Tower)	66	32.9**	29.9**	-3.0	39.7**	37.0**	-2.7	42.2*	43.5**	+1.3	-1.47
		73	23.2**	24.1**	+0.9	32.0**	32.5**	+0.5	39.4*	39.1*	-0.3	+0.37
VII	South Block (Old John Hancock Bldg.)	80	25.3**	24.5**	-0.8	31.4**	31.7**	+0.3	37.6*	37.6*	0	-0.17
		87	20.6*	19.1*	-1.5	27.0*	24.9	-2.1	34.6	32.3	-2.3	-1.97
VIII	South East Block	94	14.5	17.6	+3.1	20.6	23.9	+3.3	27.6	30.9	+3.3	+3.23
IX	East Block	104	12.7	14.5	+1.8	18.8	20.8	+2.0	25.9	28.8	+2.9	+2.23

*Exceeds Melbourne's criteria for comfortable walking (19, 27, 37 mph)
**Exceeds BRA Guideline Criteria (22, 31, 44 mph)

1/ This exhibit originally appeared as Table IV-41 in the BRA Draft EIR, October 1984, p. 196.

EXHIBIT IV-13

Comparison of Annual Velocities for Revised Project Design

1% Predicted Average, Effective Gust, and Peak Gust Velocities (MPH)

Comparison Between Different Configurations for the 1% Predicted Average, Effective Gust and Peak Gust Velocities (mph)
(includes only listings for existing, 50' & 60' spacings)

Area	Station No.	Configuration	Average Velocity	Average Difference	Effective Gust Velocity	Effective Gust Difference	Peak Gust Velocity	Peak Gust Difference	Ave. Diff.
Sidewalks around complex	1	Existing	9.5		16.2		24.5		
		50' spacing	12.0	+2.5	18.8	+2.6	25.2	+0.7	+1.93
		60' spacing	11.4	+1.9	17.3	+1.1	24.8	+0.3	+1.10
	3	Existing	10.8		17.3		24.2		
		50' spacing	14.8	+4.0	21.5	+4.2	29.5	+5.3	+4.50
		60' spacing	14.5	+3.7	22.1	+4.8	30.5	+6.3	+4.93
	5	Existing	14.5		21.6		29.9		
		50' spacing	14.7	+0.2	22.1	+0.5	29.8	-0.1	+0.20
		60' spacing	14.5	0.0	21.7	+0.1	29.0	-0.9	-0.23
	7	Existing	18.6		27.3		36.3		
		50' spacing	16.6	-2.0	23.6	-3.7	31.4	-4.9	-3.53
		60' spacing	16.2	-2.4	23.0	-4.3	30.6	-5.7	-4.13
	9	Existing	15.0		23.8		33.3		
		50' spacing	15.4	+0.4	23.4	-0.4	31.4	-1.9	-0.63
		60' spacing	15.8	+0.8	23.6	-0.2	30.5	-2.8	-0.73
	11	Existing	21.7		29.2		35.8		
		50' spacing	12.9	-8.8	19.8	-9.4	28.0	-7.8	-8.67
		60' spacing	15.6	-6.1	22.6	-6.6	31.3	-4.5	-5.73
	12	Existing	19.8		28.4		35.3		
		50' spacing	20.1	+0.3	26.1	-2.3	33.1	-2.2	-1.40
		60' spacing	21.5	+1.7	27.3	-1.1	33.8	-1.5	-0.30
	14	Existing	10.6		18.6		25.6		
		50' spacing	16.5	+5.9	21.7	+3.1	27.4	+1.8	+3.60
		60' spacing	20.2	+9.4	25.1	+6.5	30.1	+4.5	+6.80
Sidewalks around complex	15	Existing	14.6		19.6		24.7		
		50' spacing	17.7	+3.1	23.6	+4.0	30.3	+5.6	+4.23
		60' spacing	18.2	+3.6	24.2	+4.6	30.1	+5.4	+4.53
	17	Existing	19.8		24.2		30.0		
		50' spacing	11.8	-8.0	16.9	-7.3	23.3	-6.7	-7.33
		60' spacing	13.1	-6.7	18.7	-5.5	25.2	-4.8	-5.67
	19	Existing	16.3		23.6		29.3		
		50' spacing	10.9	-5.4	15.9	-7.7	21.9	-7.4	-6.83
		60' spacing	12.6	-3.7	17.8	-5.8	23.9	-5.4	-4.97
Walkways inside complex	24	Existing	9.1		15.2		21.0		
		50' spacing	9.1	0.0	14.7	-0.5	21.8	+0.8	+0.10
		60' spacing	8.3	-0.8	13.2	-2.0	18.6	-2.4	-1.73
	28	Existing	14.8		21.2		27.6		
		50' spacing	17.1	+2.3	12.3	-8.9	19.9	-7.7	-4.77
		60' spacing	6.5	-8.3	11.0	-10.2	16.8	-10.8	-9.77
Northeast block	31	Existing	17.7		24.4		33.5		
		50' spacing	17.6	-0.1	23.9	-0.5	31.5	-2.0	-0.87
		60' spacing	18.0	+0.3	23.9	-0.5	32.6	-0.9	-0.37
	33	Existing	10.9		18.4		28.0		
		50' spacing	10.7	-0.2	17.7	-0.7	25.8	-2.2	-1.03
		60' spacing	11.2	+0.3	18.8	+0.4	26.9	-1.1	-0.13

TABLE IV-13 continued

Area	Station No.	Configuration	Average Velocity	Average Difference	Effective Gust Velocity	Effective Gust Difference	Peak Gust Velocity	Peak Gust Difference	Ave. Diff.
North block	39	Existing	13.3		21.2		30.4		
		50' spacing	14.0	+0.7	21.9	+0.7	32.9	+2.5	+1.30
		60' spacing	13.3	0.0	20.5	-0.7	28.7	-1.7	-0.80
	43	Existing	10.6		16.5		24.2		
		50' spacing	9.1	-1.5	17.8	+1.3	23.9	-0.3	-0.17
		60' spacing	9.4	-1.2	15.1	-1.4	23.1	-1.1	-1.23
Northwest block	48	Existing	18.9		26.6		33.3		
		50' spacing	21.2	+2.3	28.7	+2.1	36.6	+3.3	+2.57
		60' spacing	18.7	-0.2	25.9	-0.7	33.5	+0.2	-0.23
West block (Trinity Church) (Copley Park)	52	Existing	18.3		25.6		34.2		
		50' spacing	18.2	-0.1	25.0	-0.6	33.1	-1.1	-0.60
		60' spacing	17.8	-0.5	25.0	-0.6	33.5	-0.7	-0.60
	53	Existing	19.1		25.6		33.8		
		50' spacing	18.2	-0.9	25.4	-0.2	33.3	-0.5	-0.53
		60' spacing	17.5	-1.6	23.7	-1.9	30.5	-3.3	-2.27
	59	Existing	23.9		32.1		39.0		
		50' spacing	27.3	+3.4	35.2	+3.1	42.1	+3.1	+3.20
		60' spacing	24.8	+0.9	32.2	+0.1	39.1	+0.1	+0.37
	62	Existing	26.9		33.9		39.3		
		50' spacing	27.1	+0.2	33.5	-0.4	39.0	-0.8	-0.33
		60' spacing	26.9	0.0	33.6	-0.3	38.6	-1.2	-0.50
Southwest block (John Hancock Tower)	66	Existing	32.9		39.7		42.2		
		50' spacing	29.9	-3.0	37.0	-2.7	43.5	+1.3	-1.47
		60' spacing	30.5	-2.4	37.4	-2.3	44.1	+1.9	-0.93
	73	Existing	23.2		32.0		39.4		
		50' spacing	24.1	+0.9	32.5	+0.5	39.1	-0.3	+0.37
		60' spacing	24.2	+1.0	32.7	+0.7	40.0	+0.6	+0.77
South block (Old John Hancock Building)	80	Existing	25.3		31.4		37.6		
		50' spacing	24.5	-0.8	31.7	+0.3	37.6	0.0	-0.17
		60' spacing	24.8	-0.5	32.2	+0.8	37.8	+0.2	+0.17
	87	Existing	20.6		27.0		34.6		
		50' spacing	19.1	-1.5	24.9	-2.1	32.3	-2.3	-1.97
		60' spacing	20.1	-0.5	25.9	-1.1	33.1	-1.5	-1.03
Southeast block	94	Existing	14.5		20.6		27.6		
		50' spacing	17.6	+3.1	23.9	+3.3	30.9	+3.3	+3.23
		60' spacing	16.7	+2.2	23.3	+2.7	30.5	+2.9	+2.60
East block	104	Existing	12.7		18.8		25.9		
		50' spacing	14.5	+1.8	20.8	+2.0	28.8	+2.9	+2.23
		60' spacing	15.7	+3.0	20.7	+1.9	27.1	+1.2	+2.03

EXHIBIT IV-14

Melbourne's Category at Each Station

(see Exhibit IV-21)

Area	Station No.	Existing	50' sp.	60' sp.	Tree #1	Tree #2	Tree #3
Sidewalks around complex	1	4	4	4			
	3	4	3	3			
	5	3	3	3			
	7	2	3	3			
	9	3	3	3		4	4
	11	2	4	3	5	5	5
	12	2	2	2	5	4	5
	14	4	3	2	5	5	5
	15	4	3	3			
	17	2	4	4			
	19	3	5	4			
Walkways inside complex	22		3	4			
	24	4	5	5			
	26		4	4			
	28	3	5	5			
	110		3	4			
	111		3	5			
Northeast block	31	3	3	3			
	33	4	4	4			
North block (Existing NEL)	39	3	3	4			
	43	4	5	4			
Northwest block	48	3	2	3			
West block	52	3	3	3			
(Trinity Church	53	2	3	3			
Copley Park)							
	59	2*	1*	2*	2	3	4
	62	2*	1*	2*	2*	1*	2*
Southwest block	66	1*	1*	1*	1*	1*	1*
(John Hancock Tower)	73	2*	2	2	2		
South block	80	2*	2	2*	2		
(Old John Hancock Bldg.)	87	2	2	2			
Southeast block	94	4	3	3			
East block	104	4	4	3			

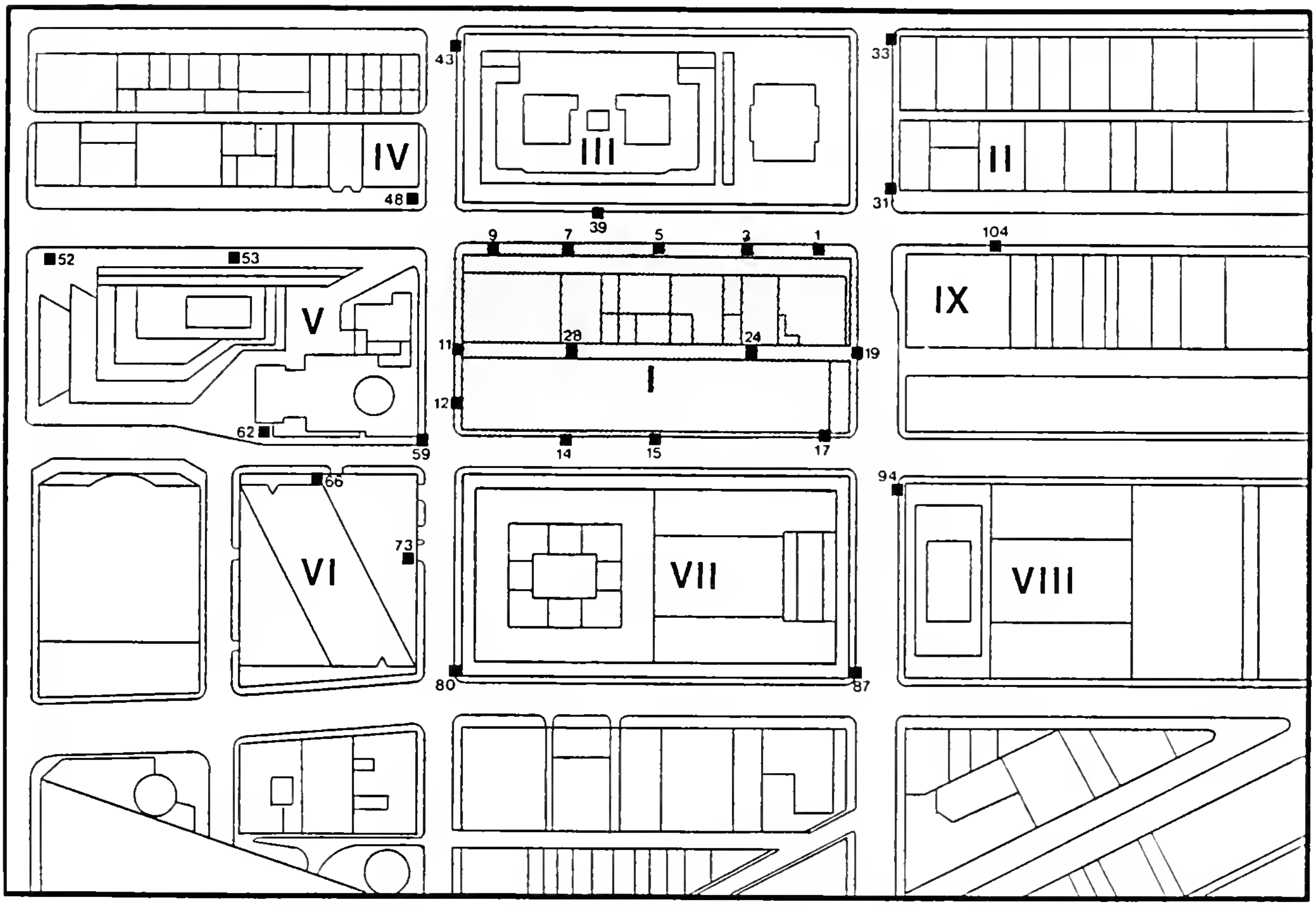
* Exceeds BRA Guideline Velocity

Melbourne's Criteria Levels

1 Unacceptable/Dangerous
2 Uncomfortable for Walking
3 Acceptable for Walking
4 Stationary Short Exposure
5 Stationary Long Exposure

EXHIBIT IV-15

28 Stations Tested for Existing Conditions 1/2/

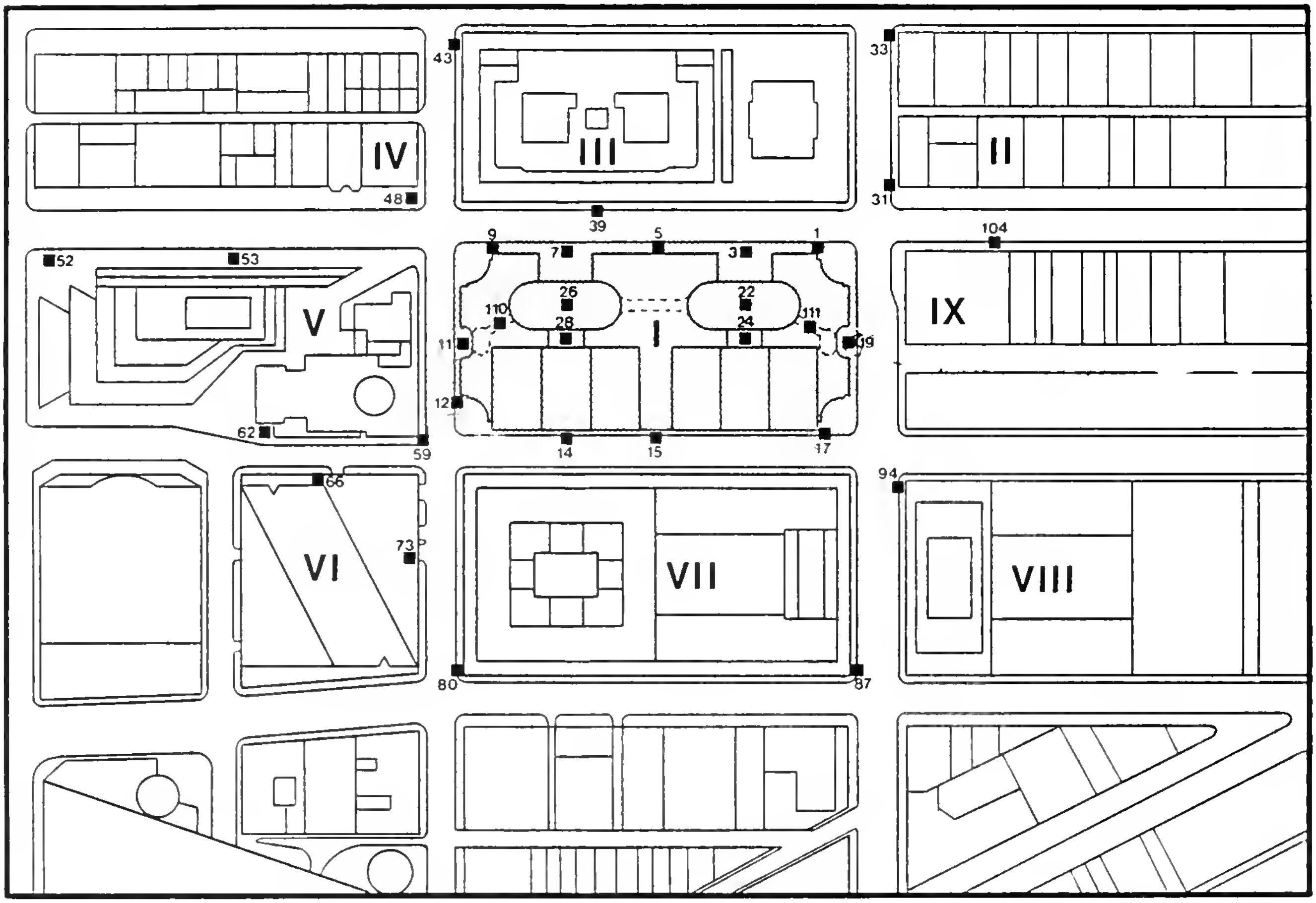


1/ Stations for the hot-wire analysis were selected from the 109 stations used in the earlier wind erosion test.

2/ This exhibit originally appeared as Figure IV-31 in the BRA Draft EIR, October 1984, p. 188.

EXHIBIT IV-16

32 Stations Tested for Project 1/2/



1/ Stations for the hot-wire analysis were selected from the 109 stations used in the earlier wind erosion test. With the 500 Boylston Street Project, new open pedestrian spaces are created on the site; therefore, four additional stations were tested.

2/ This exhibit originally appeared as Figure IV-32 in the BRA Draft EIR, October 1984, p. 189.

COMMENT 47: Some seasonal increases are not reflected in the annual statistics.

RESPONSE: Seasonal changes in wind velocities were not discussed in the BRA Draft EIR text, though they were presented in data tables in the accompanying Technical Appendix for Wind. Increased wind velocities were observed for the fall, winter, and spring seasons, but in lesser magnitudes than the decreases demonstrated for summer. The annual velocities are statistical averages based upon the seasonal probabilities for each wind velocity. The probability of a given velocity occurring in each of four seasons, when summed, should equal the probability of that velocity occurring annually. Therefore, the average of the one percent predicted velocities for each of the four seasons is not equal to the annual one percent predicted velocity. Exhibit IV-17 includes the seasonal changes in wind speed at each station for all three wind velocity types.

COMMENT 48: Of the 32 stations compared, winds increased at 12 stations (or 38%), some by as much as 5.9 mph. Therefore, it is somewhat misleading to conclude that on the average winds will be reduced or remain unchanged. At station 48 (corner Clarendon and Boylston) the project causes existing acceptable conditions to become unacceptable, and at stations 12, 59, 62, 66, 73 and 80 existing unacceptable conditions will be further exacerbated, by various degrees, by the project.

RESPONSE: Although 12 of the 32 stations tested in the May 1984 hot-wire tests for the Draft EIR experienced increased winds with the proposed project in place as compared with existing conditions, and as measured by the average difference in the three wind velocity types (see Exhibit IV-12 and 14), only nine increased significantly (i.e., by a magnitude greater than 1.0 mph): stations 1, 3, 14, 15, 39, 48, 59, 94, and 104. In addition, 16 stations experienced decreased winds as measured by the average difference in the three wind velocity types--10 of those stations significantly (stations 7, 11, 12, 17, 18, 28, 33, 43, 66, and 87). Seven stations moved to a less acceptable Melbourne's criteria level (3, 14, 15, 48, 59, 62, and 94), and eight stations moved to at least one more acceptable criteria level (7, 11, 17, 19, 24, 28, 43, and 53).

EXHIBIT IV-17

Comparison, Annual and Seasonal 100 hr. Return Period Velocities for Existing Conditions and Proposed Project 1/

Area	Station Number	100 hr. Return Period, Average Velocity: Annual	Diff. Spring - Annual	Diff. Summer - Annual	Diff. Fall - Annual	Diff. Winter - Annual	100 hr. Return Period, Effective Gust: Annual	Diff. Spring - Annual	Diff. Summer - Annual	Diff. Fall - Annual	Diff. Winter - Annual	100 hr. Return Period, Peak Gust: Annual	Diff. Spring - Annual	Diff. Summer - Annual	Diff. Fall - Annual	Diff. Winter - Annual
Ia Sidewalks around complex	1	12.0	0.3	-0.8	0.2	0.5	18.1	0.6	-1.6	0.2	0.6	25.2	1.1	-3.1	0.1	0.9
	3	14.8	0.9	-1.7	-0.1	0.2	21.5	1.1	-2.5	0.1	0.6	29.5	1.3	-3.6	0.3	1.1
	5	14.7	1.0	-2.0	0.1	0.3	22.1	1.4	-2.4	0.3	0.4	29.8	1.6	-3.5	0.5	0.6
	7	16.6	1.4	-1.1	-0.7	-0.3	23.6	1.8	-1.9	-0.8	-0.1	31.4	1.9	-3.6	-0.5	0.9
	9	15.4	0.8	-1.3	-0.1	0.3	23.4	1.2	-2.1	-0.2	0.6	31.4	1.6	-3.1	-0.2	0.7
-	11	12.9	0.3	-0.9	0.2	0.6	19.8	0.5	-1.5	0.3	0.9	✓ 28.0	1.1	-3.0	0.5	1.2
	12	20.1*	0.8*	-4.6	-1.7	2.4**	26.1	1.1*	-5.6	-1.6	2.7*	✓ 33.1	1.3	-6.6	-1.4	2.9
	14	16.5	0.6	-3.5	-1.7	2.0	21.6	0.8	-4.3	-1.8	2.5	✓ 27.4	0.9	-5.4	-1.8	2.9
	15	17.7	0.7	-3.0	-1.6	1.8*	23.6	0.9	-4.4	-1.8	2.5	✓ 30.3	1.0	-5.8	-2.2	3.2
	17	11.8	0.6	-1.4	0.0	0.4	16.9	0.8	-2.4	-0.1	0.9	23.3	0.9	-4.1	-0.4	1.7
	19	10.9	0.7	-1.5	-0.7	0.7	15.9	1.6	-2.3	-1.0	1.0	21.9	1.3	-3.6	-1.1	1.8
Ib Walkways inside complex	22	14.1	0.4	-1.2	-1.3	1.8	21.0	0.5	-4.8	-0.8	2.6	28.3	0.7	-6.4	-2.2	3.5
	24	9.1	0.3	-2.0	-0.9	1.2	14.7	0.4	-3.3	-1.5	1.8	21.8	0.7	-4.9	-1.7	2.5
	26	13.9	0.4	-2.7	-0.9	1.5	19.7	0.5	-4.1	-1.1	2.2	28.0	0.8	-5.7	-1.4	2.7
	28	7.1	0.3	-1.2	0.0	0.4	12.2	0.5	-2.2	0.0	0.7	19.8	0.9	-3.9	0.0	1.2
	110	15.2	0.5	-3.2	-0.3	1.6	21.2	0.8	-4.4	-0.5	2.0	29.5	1.2	-6.3	-1.0	2.2
	111	15.2	0.5	-3.4	-1.0	1.8	21.3	0.7	-4.7	-1.3	2.5	27.4	0.7	-6.1	-1.7	3.2
II North East Block	31	17.6	0.5	-3.9	-2.7	2.2*	23.9	0.7	-5.0	-2.0	2.9	31.4	0.9	-3.7	-2.3	3.8
	33	10.7	0.4	-2.2	-1.0	1.1	17.7	0.6	-3.7	-1.5	1.9	25.7	0.8	-5.1	-1.6	2.8
III North Block	39	14.0	0.8	-2.0	0.2	0.7	21.9	1.2	-3.1	0.1	0.7	32.9	2.1	-4.1	0.0	0.6
(Existing NEL)	43	9.1	0.4	-0.8	-0.1	0.2	14.8	0.5	-1.4	0.0	0.4	23.9	1.3	-2.9	-0.1	1.2
IV North West Block	48	21.2*	0.9**	-1.1*	1.2**	-0.8*	28.7*	2.4**	-1.8	-1.3*	-0.5*	36.6	2.7*	-3.3	-0.9	0.3
V West Block	52	18.2	0.5	-4.1	-0.9	1.9*	25.0	0.7	-5.5	-1.4	2.7*	33.1	1.0	-7.2	-1.9	3.6
(Trinity Church)	53	18.2	1.4*	-1.8	-0.5	0.2	25.4	1.8*	-2.4	-0.8	0.3	33.3	2.1	-3.7	-0.2	0.9
(Copley Park)	59	27.3**	2.8**	-6.5*	0.7**	0.7**	35.2**	3.0**	-12.3	1.1**	1.4**	42.1*	3.1**	-9.4	1.1**	1.6*
	62	27.1**	2.1**	-4.7**	0.3**	0.7**	35.5**	2.6**	-6.2*	0.6**	0.9**	39.0*	2.7*	-7.0	0.6*	1.3*
VI South West Block	66	29.9**	1.9**	-7.3**	-0.7**	2.2**	37.0**	2.1**	-9.1*	-0.8**	2.9**	43.5**	2.1**	-10.1	-0.9*	3.7*
J.Hancock Tower	73	24.1**	1.9**	-4.7*	-0.1**	0.9**	32.5**	2.4**	-5.8	-0.1**	1.2**	39.1*	2.5*	-7.2	-0.3*	2.0*
VII South Block	80	24.5**	1.7**	-4.7*	0.2**	1.3**	31.7**	2.2**	-6.7	0.2**	1.7**	37.6*	2.1*	-7.3	-0.2*	2.4*
Old J.Hancock Bldg	87	19.1*	1.2*	-2.7	-0.1*	0.6*	24.9	1.7	-3.7	0.2	1.0	32.3	2.3	-5.1	0.3	1.1
VIII South East Bl.	94	17.6	0.7	-3.2	-1.2	1.9*	23.9	0.9	-4.4	-1.2	2.2	30.8	1.4	-5.5	-1.1	2.8
IX East Block	104	14.5	0.4	-2.8	-0.8	1.6	20.8	0.5	-3.4	-0.8	1.9	28.7	0.8	-3.9	-0.5	2.3

* Exceeds Melbourne's criteria for comfortable walking (19, 27, 37 mph)

** Exceeds BRA criteria (22, 31, 41 mph)

1/ This exhibit originally appeared as Table 3, in the BRA Draft EIR, Appendix: Wind, p. 35.

Therefore, on the average pedestrian-level winds were determined to be reduced or at least remain unchanged.

With the revised design in place for the December 1984 tests (see Exhibit IV-13), six of the nine stations that experienced increased winds (1, 3, 14, 15, 94, and 104), as measured by the average difference in the three wind velocity types at the original 28 test stations, experienced significant changes in pedestrian-level winds, while 19 stations experienced decreased winds. Although the results of the December 1984 hot-wire wind tunnel tests show that 19 of the 32 stations will experience improved pedestrian-level wind conditions as indicated by the changes in average differences for the three wind velocity types, only nine of these nineteen stations experienced reductions in wind speed of a significant magnitude. The results of the hot-wire tests comparing existing conditions to the conditions resulting from the revised project design can be evaluated for specific areas in and around the site (see Exhibits IV-13, 14, and 18). Along the sidewalks around the project site and in the area to the east, pedestrian-level winds remain essentially unchanged because roughly the same number of stations experienced decreased magnitudes in wind velocity as experienced increased magnitudes in wind velocity. In the remaining areas--the walkways within the proposed project and near Trinity Church, along Clarendon Street, the John Hancock Tower, and west of the project site--wind conditions were slightly improved. Stations 24, 28, 48, 53, and 59 exhibited significant reductions in wind velocities with the revised project design in place. Five stations moved to a less acceptable Melbourne's criteria level (3, 14, 15, 94, and 104), and seven stations moved to a more acceptable criteria level (7, 11, 17, 19, 28, 39, and 53). The results of the hot-wire testing of the revised project design suggest that pedestrian-level winds overall will be somewhat improved from existing conditions.

While the earlier project design caused existing acceptable conditions to become unacceptable at station 48 and exacerbated existing unacceptable conditions at stations 12, 59, 62, 66, 73, and 80, the revised project design slightly improves wind conditions at station 48 so that it remains comfortable for walking, lessens winds at stations 12, 62, and 66, and does not significantly exacerbate stations 59, 73, or 80.

EXHIBIT IV-18
PREDICTED WIND CONDITIONS WITH PROPOSED REVISED PROJECT DESIGN (AS COMPARED TO EXISTING CONDITIONS)

	Number of Stations Changed
Decreased Wind Speed 1/	19
Decreased Significantly 2/	9
Increased Wind Speed 1/	9
Increased Significantly 2/	6
Moved to a more acceptable Melbourne's Criteria Level	8
Moved to a less acceptable Melbourne's Criteria Level	5
Exceeded BRA Guideline 3/	0

1/ Wind speeds are measured here in terms of the average difference in the average, effective gust, and peak gust wind velocities.
2/ Significant changes in magnitude are assumed to be at least ±1.0 mph.
3/ Although five stations exceed the BRA Guideline under existing conditions (59, 62, 66, 73, and 80), no additional stations will exceed the BRA Guideline under proposed conditions with the revised design in place.

Existing unacceptable conditions at these three stations (59, 73, and 80) will be slightly exacerbated with the revised project design in place--at increases of less than 1.0 mph in the average difference in velocities for the three wind types. These relatively small increases in speed are within the margin of error of the testing procedure. Stations 12, 62, and 66 will experience a slight lessening in winds.

COMMENT 49: [Ref. p. 197, BRA Draft EIR] Mitigation measures have been suggested, but were not tested as required by the BRA scope. Since, as noted above, some adverse, or more adverse, conditions are created by the project, the mitigation measures should be tested and the results included in the Final EIR. The intersection of Clarendon Street and St. James Avenue is particularly critical in this regard.

RESPONSE: Subsequent to the submission of the BRA Draft EIR (October 1984), additional hot wire wind tunnel tests

were conducted to study measures to mitigate adverse pedestrian-level wind conditions created by the proposed development. The mitigation measures tested were three configurations of tree plantings (see Exhibit IV-19). Emphasis was directed toward the windiest areas surrounding the project site--near Trinity Church, along Clarendon Street, the John Hancock Tower, and west of the project (Stations 9, 11, 12, 14, 58, 59, 62, 66, 73 and 80). Tree configuration #1 includes existing trees, proposed 35-foot tall trees every 25 to 30 feet along St. James Avenue and Clarendon Street as shown on the ground floor plan, and a series of 15 and 35-foot tall trees around the John Hancock Clarendon Building. Tree configuration #2 is the same as configuration #1 with the addition of a row of 35-foot tall trees along Clarendon Street and St. James Avenue next to Trinity Church and spaced 25 to 30 feet apart. Tree configuration #3 further adds 15 to 20-foot high trees along St. James Avenue at the John Hancock Tower.

Each of these three tree configurations in the hot-wire wind tests served to significantly improve pedestrian-level wind conditions at the majority of stations tested (see Exhibit IV-20). Tree configuration #1 mitigates project wind impacts to the surrounding area to the extent that stations currently experiencing wind speeds greater than the BRA Guideline (effective gust speeds of 31 mph no greater than one percent of the time) will actually experience a reduction in effective gust wind speeds and no additional points will exceed the BRA Guideline. Tree configuration #2 further mitigates wind impacts, particularly in the area near Trinity Church, along Clarendon Street, the John Hancock Tower, and west of the project. The proponent proposes to assume planting costs for the additional trees on the Trinity Church property in tree configuration #2, though these trees are not required to meet the standard specified in the wind attachment to the scope for the BRA for wind mitigation measures. Discussions about an implementation strategy for tree configuration #2 are under way with church representatives.

Although tree configuration #2 mitigates project wind impacts, tree configuration #3 further improves pedestrian-level wind conditions near the project site, but the implementation of tree configuration #3 is dependent upon the John Hancock Mutual Life Insurance

Tree Configuration Numbers 1, 2 and 3

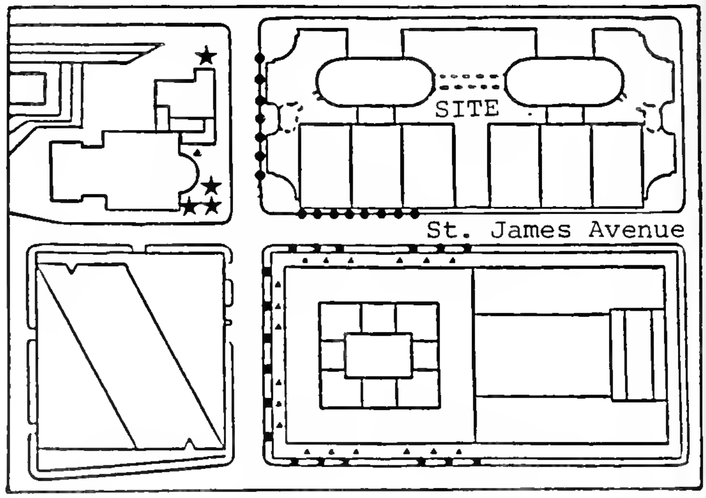
LEGEND

★ 50' Trees

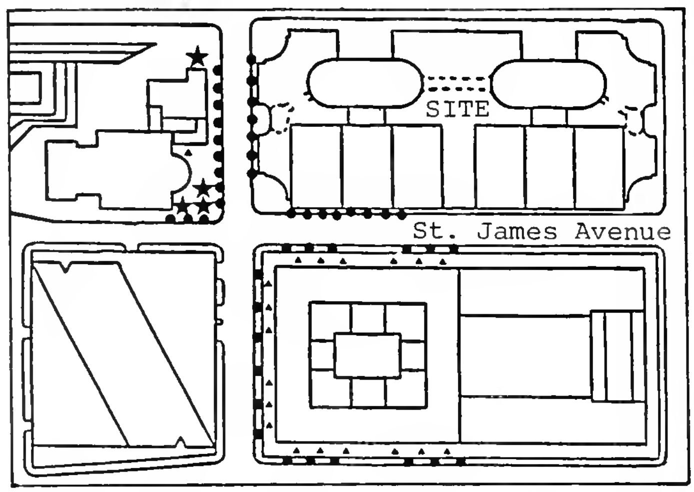
● 35' Trees

▲ 15' Trees

Tree Configuration Number 1



Tree Configuration Number 2



Tree Configuration Number 3

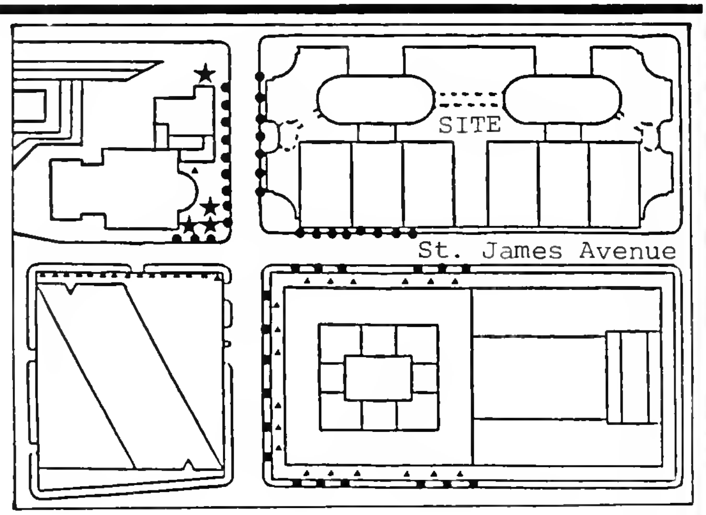


EXHIBIT IV-20

Comparison of Annual Velocities for Tree Configurations With Revised Project Design

1% Predicted Average, Effective Gust, and Peak Gust Velocities (MPH)

Mitigation Measures: Comparison of Annual Velocities for Revised Design and Different Tree Configurations for the 1% Predicted Average, Effective Gust and Peak Gust Velocities (mph) (includes only listings for existing, 60' spacing, and tree configurations tested)

Area	Station No.	Configuration	Average Velocity	Average Difference	Effective Gust Velocity	Effective Gust Difference	Peak Gust Velocity	Peak Gust Difference	Ave. Diff.
	9	Existing	15.0		23.8		33.3		
		60' spacing	15.8	+0.8	23.6	-0.2	30.5	-2.8	-0.73
		Tree 2	13.3	-1.7	20.4	-3.4	29.7	-3.6	-2.90
		Tree 3	12.9	-2.1	20.1	-3.7	29.6	-3.7	-3.17
	11	Existing	21.7		29.2		35.8		
		60' spacing	15.6	-6.1	22.6	-6.6	31.3	-4.5	-5.73
		Tree 1	9.8	-11.9	14.6	-14.6	20.5	-15.3	-13.93
		Tree 2	10.7	-11.0	15.4	-13.8	21.8	-14.0	-12.93
		Tree 3	10.6	-11.1	15.4	-13.8	21.7	-14.1	-13.00
	12	Existing	19.8		28.4		35.3		
		60' spacing	21.5	+1.7	27.3	-1.1	33.8	-1.5	-0.30
		Tree 1	8.7	-11.1	13.1	-15.3	18.8	-16.5	-14.30
		Tree 2	13.4	-6.4	17.6	-10.8	22.6	-12.7	-9.97
		Tree 3	9.3	-10.5	13.8	-14.6	19.1	-16.2	-13.77
	14	Existing	10.6		18.6		25.6		
		60' spacing	20.0	+9.4	25.1	+6.5	30.1	+4.5	+6.80
		Tree 1	9.9	-0.7	14.1	-4.5	18.2	-7.4	-4.20
		Tree 2	7.5	-3.1	10.8	-7.8	14.6	-11.0	-7.30
		Tree 3	7.5	-3.1	10.7	-7.9	14.3	-11.3	-7.43
	58	Tree 2	5.6		9.1		14.0		
		Tree 3	5.5		8.9		13.7		
	59	Existing	23.9		32.1		39.0		
		60' spacing	24.8	+0.9	32.2	+0.1	39.1	+0.1	+0.37
		Tree 1	22.6	-1.3	29.9	-2.2	36.6	-2.4	-1.97
		Tree 2	18.3	-5.6	26.4	-5.7	33.9	-5.1	-5.47
		Tree 3	14.6	-9.3	20.4	-11.7	27.2	-11.8	-10.93
	62	Existing	26.9		33.9		39.8		
		60' spacing	26.9	0.0	33.6	-0.3	38.6	-1.2	-0.50
		Tree 1	25.7	-1.2	31.8	-2.1	36.8	-3.0	-2.10
		Tree 2	27.2	+0.3	33.3	-0.6	39.4	-0.4	-0.23
		Tree 3	25.9	-1.0	32.1	-1.8	38.2	-1.6	-1.47
outhwest block .(John Hancock Tower)	66	Existing	32.9		39.7		42.2		
		60' spacing	30.5	-2.4	37.4	-2.3	44.1	+1.9	-0.93
		Tree 1	28.6	-4.3	34.9	-4.8	40.9	-1.3	-3.47
		Tree 2	28.3	-4.6	34.4	-5.3	41.7	-0.5	-3.47
		Tree 3	29.0	-3.9	35.6	-4.1	42.9	+0.7	-2.43
	73	Existing	23.2		32.0		39.4		
		60' spacing	24.2	+1.0	32.7	+0.7	40.0	+0.6	+0.77
		Tree 1	21.9	-1.3	29.8	-2.2	38.4	-1.0	-1.50
outh block (Old John Hancock Building)	80	Existing	12.7		18.8		25.9		
		60' spacing	24.8	-0.5	32.2	+0.8	37.8	+0.2	+0.17
		Tree 1	22.0	-3.3	29.1	-2.3	35.8	-1.8	-2.47

Company to achieve the planting of trees along St. James Avenue. The John Hancock Mutual Life Insurance Company is currently studying the feasibility of adding these trees as well as other landscaping and plaza modifications.

COMMENT 50:

Air flow modifications resulting from the project should be considered. Especially important in this regard is the potential for a channeling effect on St. James Street and its impacts on wind conditions and air quality (increasing dispersion or creating a canyon effect).

RESPONSE:

The hot-wire wind tunnel tests do not directly measure the characteristics of air flows. Data recorded for each station includes the magnitude and an estimate of the direction of the pedestrian-level wind velocity, for wind directions originating from each of the 16 primary compass directions. However, an evaluation of the hot-wire test data can be used to estimate general air flow modifications. A "channeling effect" assumes a continuous flow of high speed winds directed between building masses. A "canyon affect" assumes a stagnant mass of suspended air. In either scenario, at greater heights winds are usually assumed to be of a greater velocity (though not necessarily in the same direction) than they are at the pedestrian level. The hot-wire tests have shown that the stations tested along St. James Avenue experience moderate wind velocities for all three wind types (average, effective peak, and peak gust). Therefore, project implementation and the resulting moderate wind speeds along St. James Avenue, create neither channeling nor canyon effects, and so winds in this area will be capable of dispersing pollutants.

COMMENT 51:

[Ref. p. 17, BRA Draft EIR, Technical Appendix 6: Wind] The photograph of the model does not appear to include the 399 Boylston Street building. Why was this building not included? This building should be added for any retesting done.

RESPONSE:

The 399 Boylston Street building had not been completed when the wind tunnel model base was constructed for the

initial hot-wire tests. However, the 399 Boylston building and the Ritz Carlton Condominium tower addition have been included in the model for all subsequent tests introduced in this BRA Final EIR.

COMMENT 52:

[Ref. pp. 8-9, BRA Draft EIR, Technical Appendix 6: Wind]
The wind consultants make an assumption that the BRA guideline criteria for acceptability of wind is the dividing line between acceptable and uncomfortable for walking and thus is less restrictive than Melbourne's criteria. However, the BRA criterion of Ueg = 31 mph is a limit for <u>acceptability</u> and thus is equivalent to the dividing line between Melbourne's categories 1 and 2. The result is that the BRA criterion is really more restrictive than Melbourne's, used by the MIT wind tunnel. This difference should be resolved in any future studies.

RESPONSE:

In 1978 Melbourne reviewed the literature to find a probabilistic criteria for hourly average pedestrian-level winds that would cover different types of human activity as well as safety considerations. As a result, criteria were given and labeled. They are "unacceptable and dangerous," "uncomfortable for walking," "acceptable for walking," "acceptable for short periods of standing," and "acceptable for long periods of standing or sitting." This criteria schedule (defined for hourly average velocities) has been in use at the Wright Brothers Memorial Wind Tunnel (WBWT) at MIT for six years. Melbourne's criteria can also be modified to apply to both the effective gust as well as the peak gust velocities.

Since the BRA Guideline establishes a qualitative standard of "acceptability," the WBWT assumed that "uncomfortable" conditions, as defined by Melbourne's criteria, to be the equivalent qualitative standard for acceptability. Therefore the Melbourne's criterion of "uncomfortable for walking" and "dangerous and unacceptable" were considered "unacceptable," the dividing line falling between "uncomfortable for walking" and "acceptable for walking" at a velocity less than the BRA Guideline velocity for acceptability (see Exhibits IV-21 and 22).

EXHIBIT IV-21
MELBOURNE'S CRITERIA FOR 100-HOUR RETURN PERIOD

CATEGORY	WIND VELOCITIES (U)		
Comfort	Hourly Average (Uav) mph	Effective Peak Gust (Ueg) mph	Peak Gust (Upk) mph
1 Unacceptable/Dangerous	$27 \leq Uav$	$39 \leq Ueg$	$55 \leq Upk$
2 Uncomfortable for Walking	$19 \leq Uav < 27$	$27 \leq Ueg < 39$	$37 \leq Upk < 55$
3 Acceptable for Walking	$15 \leq Uav < 19$	$21 \leq Ueg < 27$	$30 \leq Upk < 37$
4 Stationary Short Exposure	$12 \leq Uav < 15$	$16 \leq Ueg < 21$	$23 \leq Upk < 30$
5 Stationary Long Exposure	$Uav < 12$	$Ueg < 16$	$Upk < 23$

EXHIBIT IV-22
COMPARISON OF CRITERIA FOR ACCEPTABLE 100-HOUR RETURN WIND VELOCITIES

CATEGORY	WIND VELOCITIES (U)		
Comfort Standard	Hourly Average (Uav)	Effective Peak Gust (Ueg)	Peak Gust (Upk)
BRA Guideline	22	31	43
Melbourne Criteria (uncomfortable for walking)	19	27	37

COMMENT 53:

[Ref. pp. 33, 35, Tables 1 and 3, BRA Draft EIR, Technical Appendix 6: Wind]
Why are some of the wind velocities different for the same station? For example:

Station 1 (proposed) - effective gust = 18.8 (Table 1)
= 18.1 (Table 3)

There are several other examples. Which are the correct numbers?

RESPONSE:

The discrepancies in wind velocities for the same stations in the wind appendix tables have been corrected. (See BRA Final EIR, Appendix 3: Wind.)

COMMENT 54:	[Ref. pp. 39ff, BRA Draft EIR, Technical Appendix 6: Wind] On several pages of the discussion, symbols and formulae are missing.
RESPONSE:	The missing symbols and formulae in the wind appendix on pages 39ff have been included. (See BRA Final EIR, Appendix 3: Wind.)

COMMENT 55:	[Ref. p. 44, BRA Draft EIR, Technical Appendix 6: Wind] Why were surface wind data from Logan, rather than winds aloft data, used? Would not the winds aloft data be more reliable since they would be unaffected by surface features (such as tall buildings which are added over time). Winds aloft data are available and have been used in other wind studies in Boston.
RESPONSE:	MIT's Wright Brothers Memorial Wind Tunnel (WBWT) uses surface wind data taken at Logan Airport between 1945 and 1965 instead of winds aloft data for several reasons. During this 20 year period, surface winds were recorded once every hour, 24 times a day. After 1965 data was recorded every three hours, comprising a smaller data base than the data collected from 1945 to 1965. Difficulties typically arise in the use of surface data because it is susceptible to unknown interference effects and the likelihood that the location and height of the weather station has changed over time. However, some of these difficulties are lessened by taking readings at airport sites where land and building interferences are minimized, as compared with typical urban conditions.

The advantage of winds aloft or other data taken at heights far away from the ground is that they are relatively unaffected by local terrain or obstructions. However, data readings are taken two or four times a day, limiting the number of observations as compared to the 20 year surface data from Logan Airport. In addition, since the acquisition of the data involves releasing a balloon, the tendency is to release the balloon during a calm period, introducing a bias that excludes the most extreme winds.

WBWT has been performing a study of the various types of wind data available for Boston. Two sets of winds

aloft data and three sets of surface data are compared in Exhibit IV-23, which shows the percent of the time the wind comes from each of the sixteen major compass directions. Surface data from 1945 to 1965 are compared with surface data from 1965-1975 and eight years of winds aloft surface data (data taken at the surface). There is a great disparity in the number of observations (all taken at Logan Airport): 176,000 (1945-1965), 28,000 (1965-1975), and 4,800 (1965-1973). Additional winds aloft data from an early study at the National Oceanic and Atmospheric Administration, sponsored by the University of Western Ontario, are compared with some combined data from Portland, ME, Chatham, MA, Nantucket, MA, and Albany, NY.

The surface data from 1965 to 1975 compares poorly with both the 1945-1965 surface data and the winds aloft data. The main difference between the 1945-1965 surface data and the winds aloft data is that the surface data includes more easterly winds. WBWT believes this to be a real effect, due to the typical easterly sea breezes caused by the cold ocean, occuring in the spring and summer. Under these conditions, the winds aloft data would appear as west or southwest winds.

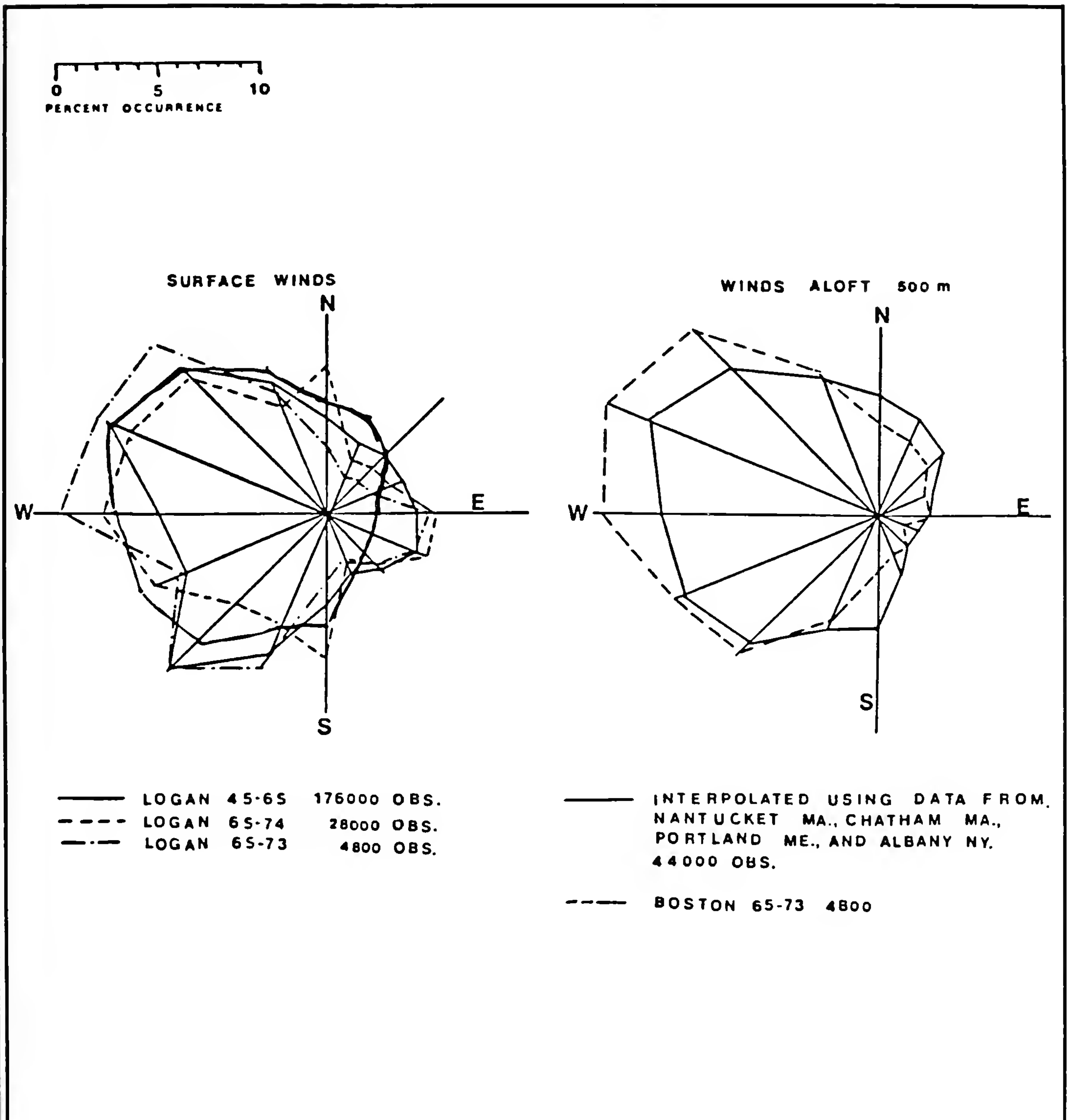
Characteristics of the surface data collected at Logan Airport between 1945 and 1965, such as the large number of observations, general agreement with winds aloft data, and incorporation of easterly sea breezes, demonstrate that it is a better source of wind data than the winds aloft data.

COMMENT 56: [Ref. p. 49, BRA Draft EIR, Technical Appendix 6: Wind] Figure numbers are incorrect; should refer to 12 a, b, c, not 11a, b, c, etc.

RESPONSE: Correction noted. (See p. 49, BRA Final EIR, Appendix 3: Wind.)

COMMENT 57: [Ref. p. 116, BRA Draft EIR, Technical Appendix 6: Wind] Why are the Weibull constants for Boston used for this

Boston Wind Roses



study different from those used in the Rowes Wharf wind study, also done by MIT (see page 165 of Rowes Wharf Final EIR, Appendix 5)?

RESPONSE:

The Weibull coefficients used in the Rowes Wharf and the 500 Boylston Street studies are based on the same wind data. However, Rowes Wharf Weibull coefficients were obtained for annual wind conditions without considering the reduction of data into seasonal probabilistic components, whereas the 500 Boylston Street project coefficients were derived for use in predicting both annual and seasonal probabilistic characteristics of the winds. In order to obtain the Weibull coefficients for each of the 16 wind directions and each of the four seasons, the average number of data entries for each direction for each season contains only 1/64th (one for each of 16 wind directions, times four for each of the seasons) of the total observations. For example, as shown in Exhibit IV-23, with 4,800 observations only about 75 will be observations for each direction for each season, which is a very limited sample. When the coefficients were derived for predicting both the annual and seasonal characteristics of the winds for the 500 Boylston Street project, it was found that the seasonally derived results were not consistent with the annual results used for the Rowes Wharf Study. The changes in the annual results used in the Rowes Wharf and the 500 Boylston Street reports were the result of the Wright Brothers Memorial Wind Tunnel reworking the data to make the annual and seasonal sets of coefficients consistent so that the annual probabilities equal the sum of the probability of a given wind occurring in each season.

Shadow

INTRODUCTION

A series of shadow analyses have been performed for the 500 Boylston Street Project to predict and evaluate the extent of new project-generated shadows in the Back Bay.

In 1983, a preliminary shadow study was presented to the BRA and the St. James Civic Advisory Committee describing existing and new shadows for the project. At that time the plans called for a tower height of 396 feet and a separation of 40 feet between the two towers. The analysis considered the shadows cast at 10:00 AM and 3:00 PM on December 21, March 21, and June 21. Manual, desk top techniques were used to calculate the impacts. The results were presented graphically on 22-inch square boards, which compared shadows for existing and proposed conditions at each of the two times of day studied. Although no formal impact assessment was conducted using these presentation panels, an examination of the data suggests that in the six-block study area, the new shadows cast by the project constitute a small increment to the existing shadow environment.

In 1984 a computer-generated shadow study was carried out as part of the environmental analysis for the BRA Draft EIR. The study area included 32-blocks of the Back Bay, bounded by Beacon Street, Arlington Street, Columbus Avenue, Copley Place, and Exeter Street. For this analysis, the proposed towers were assumed to be 330 feet tall with a 60-foot separation between the towers. Shadow analyses were conducted for September 21 (Autumnal Equinox, average shadow conditions equivalent to those on March 21, the Vernal Equinox), June 21 (Summer Solstice, minimum shadow conditions), and December 21 (Winter Solstice, maximum shadow conditions) at three times of day: 9:00 AM, Noon and 3:00 PM, as specified in the scope for the BRA. Figures IV-34, IV-35, and IV-36 in the BRA Draft EIR presented the results of these analyses. Shadows cast by the project were superimposed on existing shadows, however, the incremental effects of the project (new shadows) were not readily distinguishable. Accompanying the shadow diagrams, the Draft EIR presented a written assessment of shadow impacts of the project on the Back Bay, focusing on four receptor areas: Boylston Street pedestrian and retail area, Copley Square, Commonwealth Avenue Mall, and the public plazas created by the 500 Boylston Street project.

Subsequent to the submission of the BRA Draft EIR, and following discussions with representatives of the BRA and the CAC, additional technical analyses were conducted to further refine the precision of the computer-based studies, to further identify the incremental effects of the proposed project, and to conduct detailed computer-based analyses of the shadow environment (existing and proposed) at the Clarendon Street Playground.

The precision of the shadow studies was enhanced by the incorporation of correction factors for latitude and solar time into the computer shadow computations. Studies for the Draft EIR assumed a latitude for the Back Bay of 42.2^{o}. The actual latitude is approximately $42^{o}21'$ (42.35^{o}). This correction results in a lengthening of less than one percent of predicted early morning and late afternoon winter shadows cast by all Back Bay structures considered in this analysis.

Solar time corrections were also incorporated into this analysis. Because the earth's orbit is an ellipse, seasonal variations in actual solar time (as compared to standard time) can amount to as much as 16 minutes. Solar time at a point on earth is also affected by its exact location within a standard time zone. Because Boston is $3^{o}55'$ east of the standard meridian (75^{o}W) for the Eastern Standard Time Zone, solar time in Boston is approximately 15 minutes 45 seconds ahead of standard time. The net effect of these corrections is that by comparison to the Draft EIR solar times range from approximately 32 minutes ahead of Eastern Standard Time in October to approximately 3 minutes ahead of Eastern Standard Time in February. Exhibits IV-24, 25, and 26 incorporate these corrections.

In order to accentuate the incremental shadows cast by the 500 Boylston Street Project, a modified graphic presentation format was adopted. Such new shadows are identified as a separate graphic pattern in Exhibits IV-24, 25, and 26.

Based on concerns expressed by the St. James CAC, the proponent undertook a detailed shadow analysis for the Clarendon Street Playground. The study examined the immediate playground area at weekly intervals from October 26 to February 15, focusing on the time period from 7:30 AM to 10:00 AM at 15-minute intervals. The analysis addresses shadows cast on the ground plane by

EXHIBIT IV-24

Spring and Fall Equinox
March 21, 9:00 AM

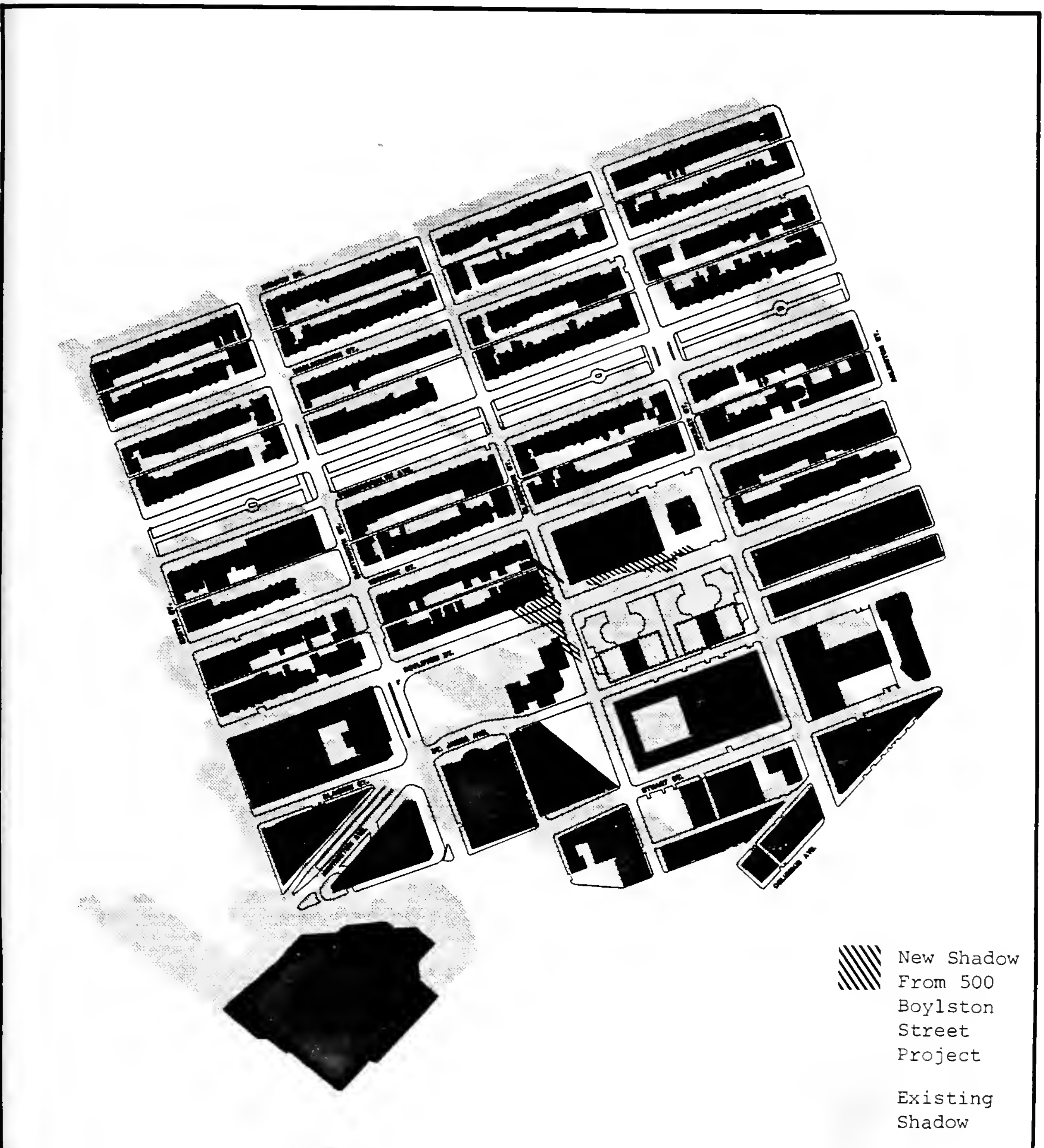


EXHIBIT IV-24
(Continued)

Spring and Fall Equinox
March 21, 12:00 Noon

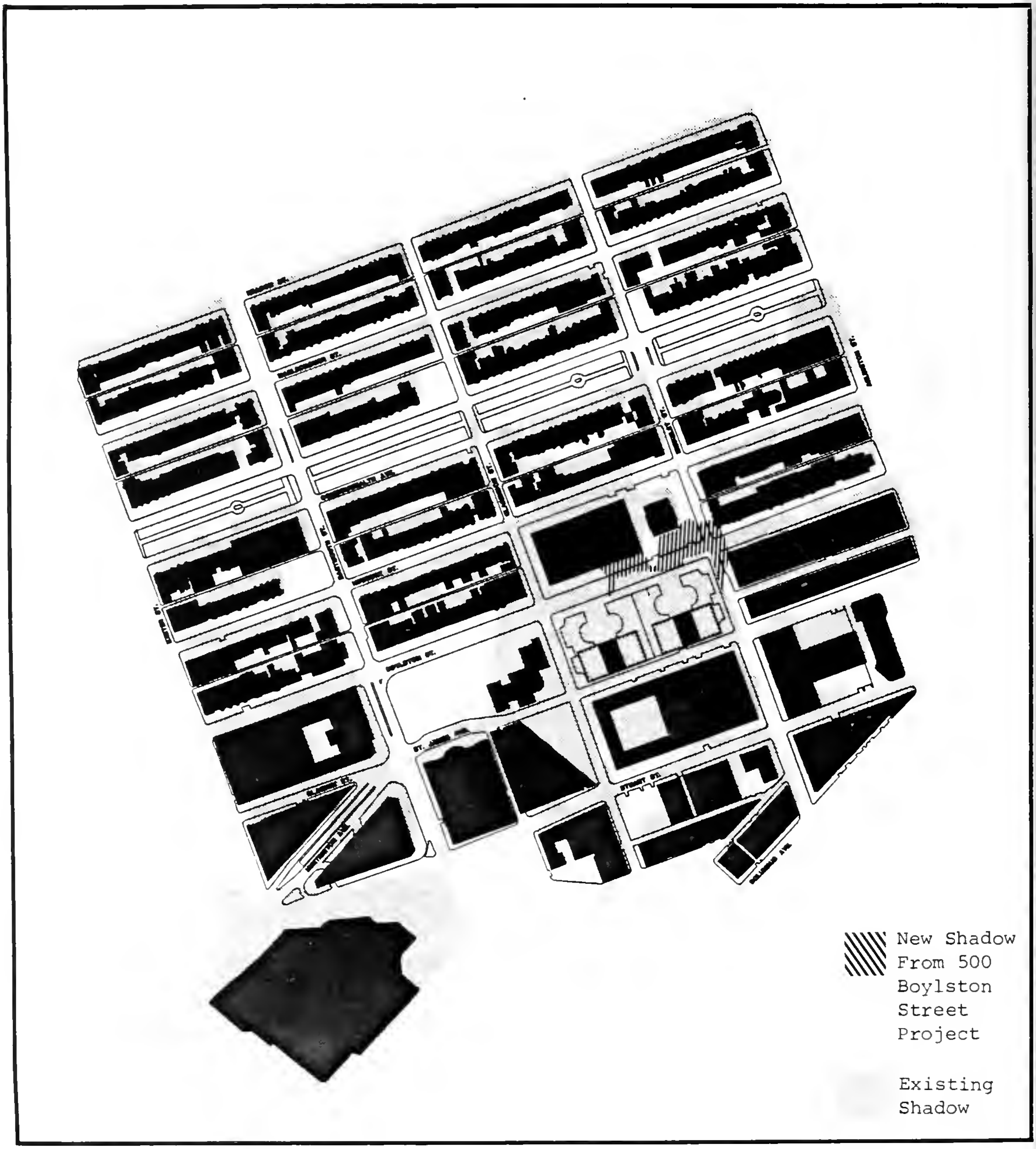


EXHIBIT IV-24
(Continued)

Spring and Fall Equinox
March 21, 3:00 PM

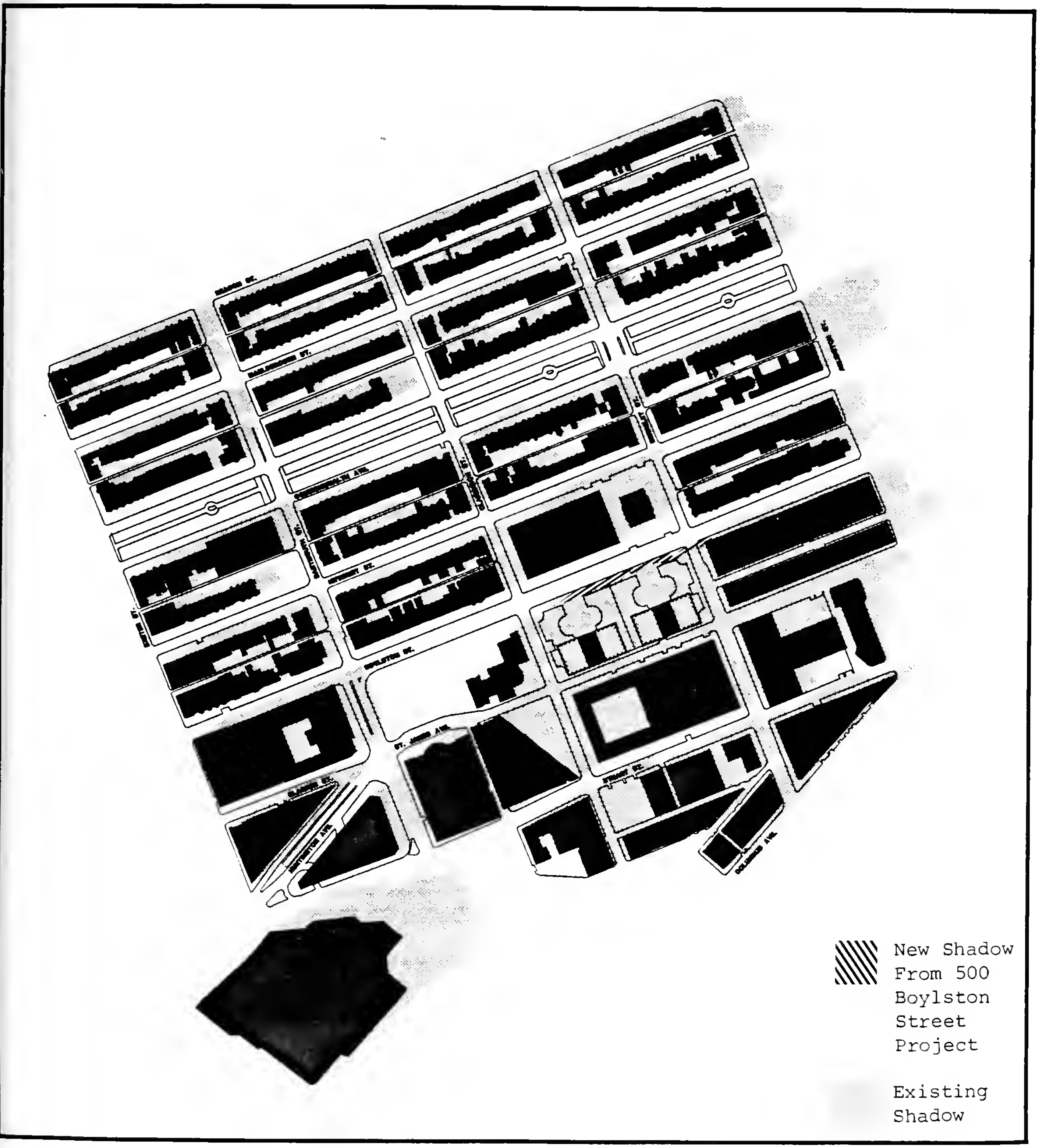
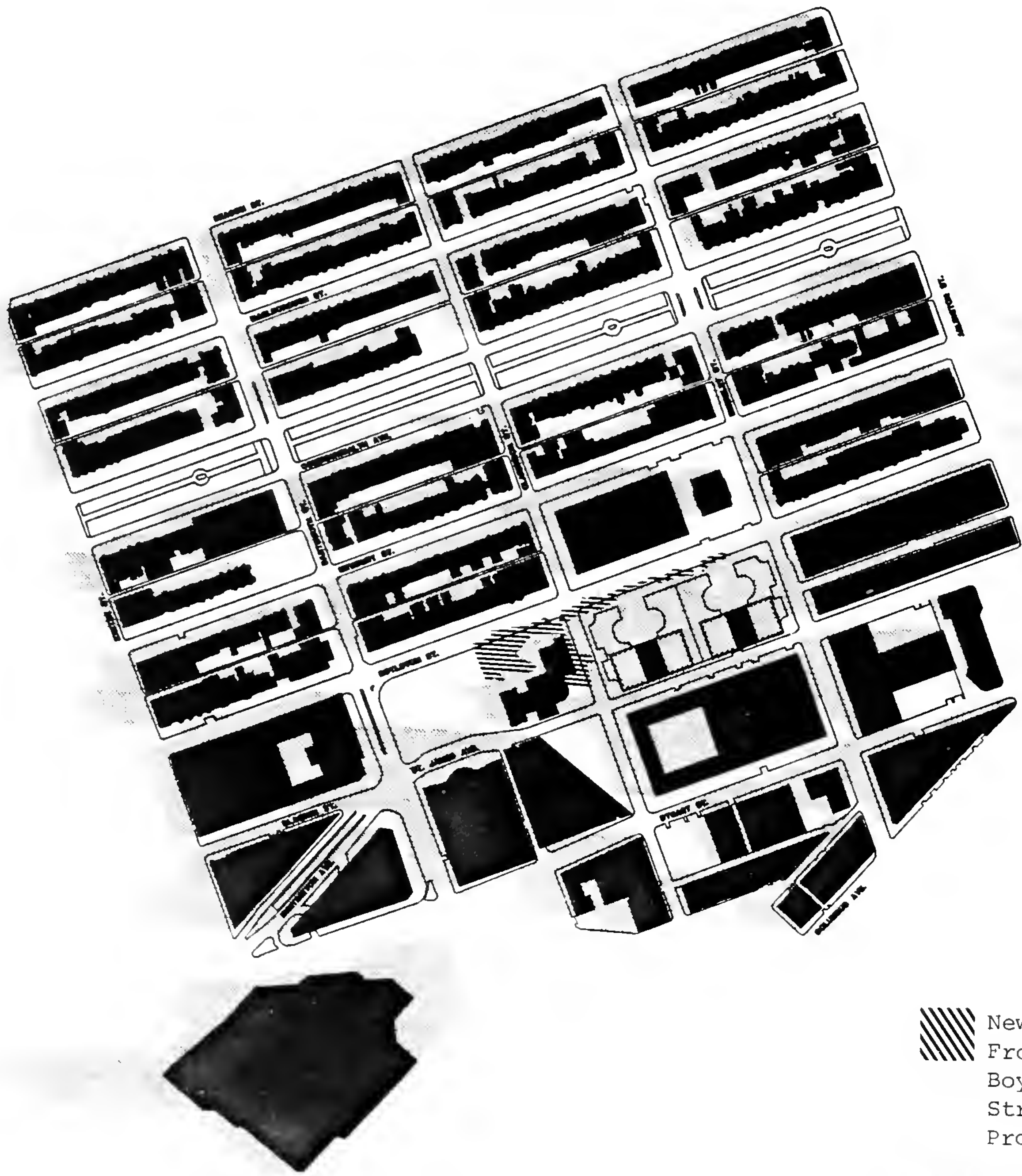


EXHIBIT IV-25

Summer Solstice
June 21, 9:00 AM

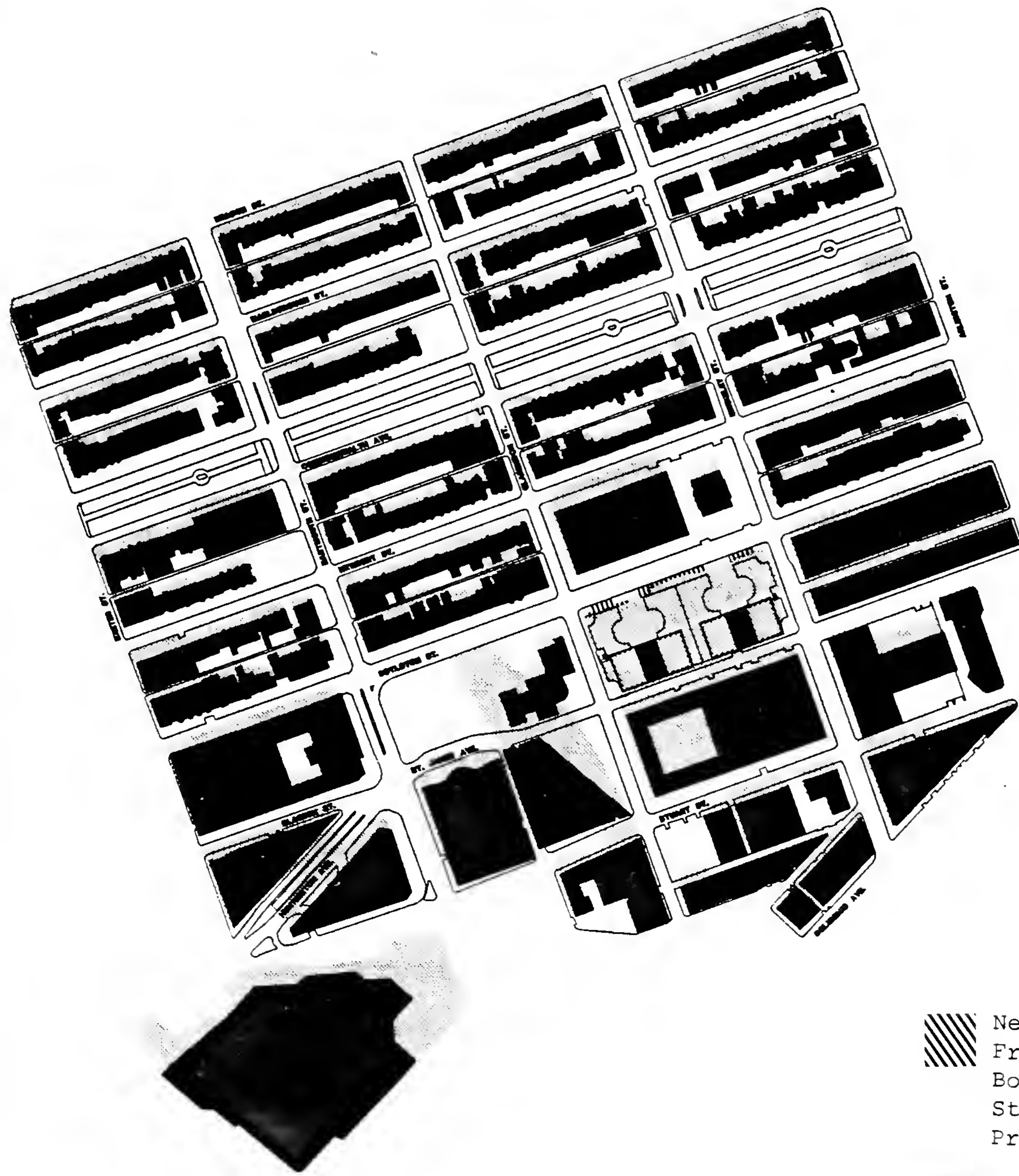


New Shadow From 500 Boylston Street Project

Existing Shadow

EXHIBIT IV-25
(Continued)

Summer Solstice
June 21, 12:00 Noon

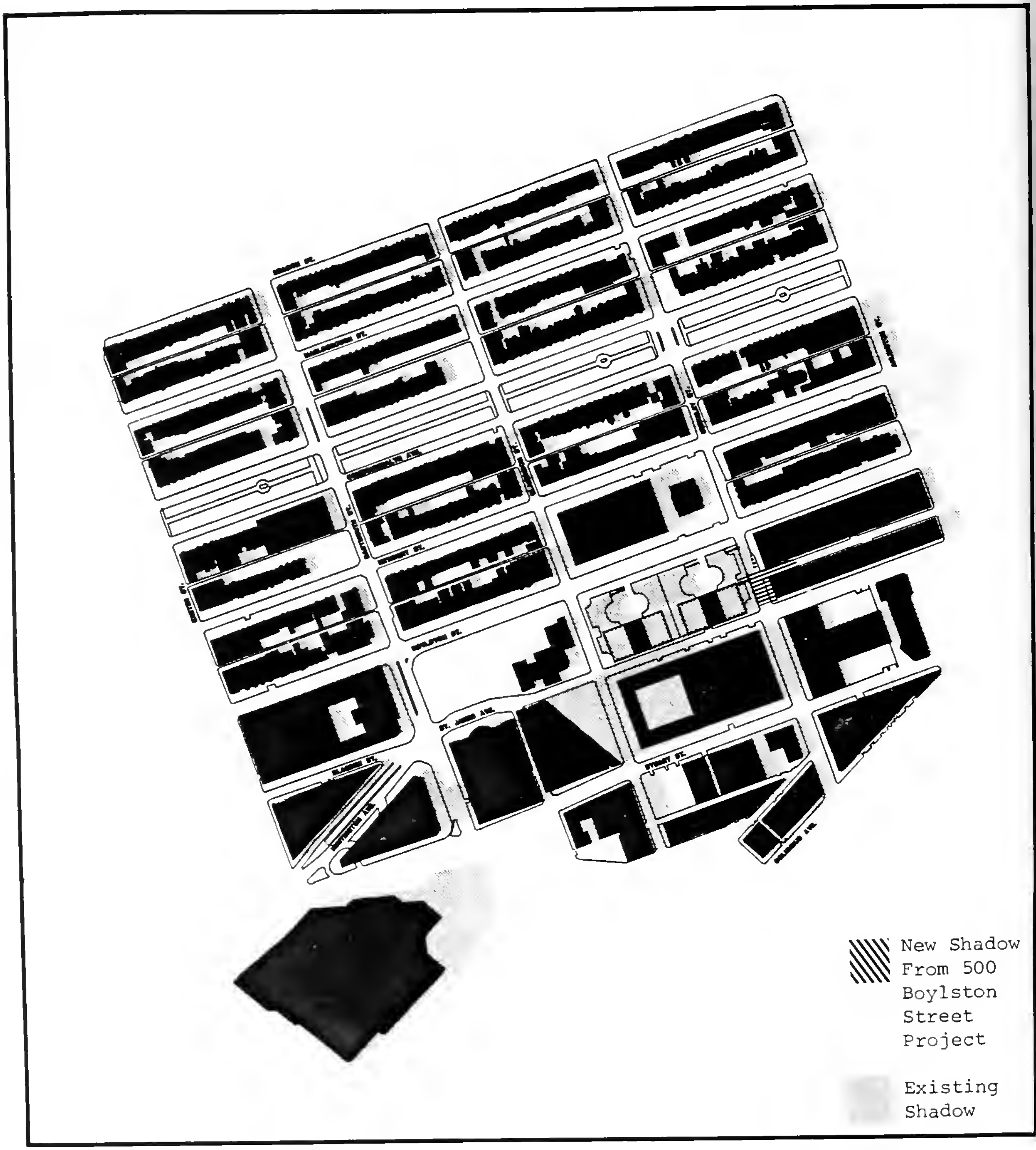


New Shadow From 500 Boylston Street Project

Existing Shadow

EXHIBIT IV-25
(Continued)

Summer Solstice
June 21, 3:00 PM



New Shadow From 500 Boylston Street Project

Existing Shadow

EXHIBIT IV-26

Winter Solstice
December 21, 9:00 AM

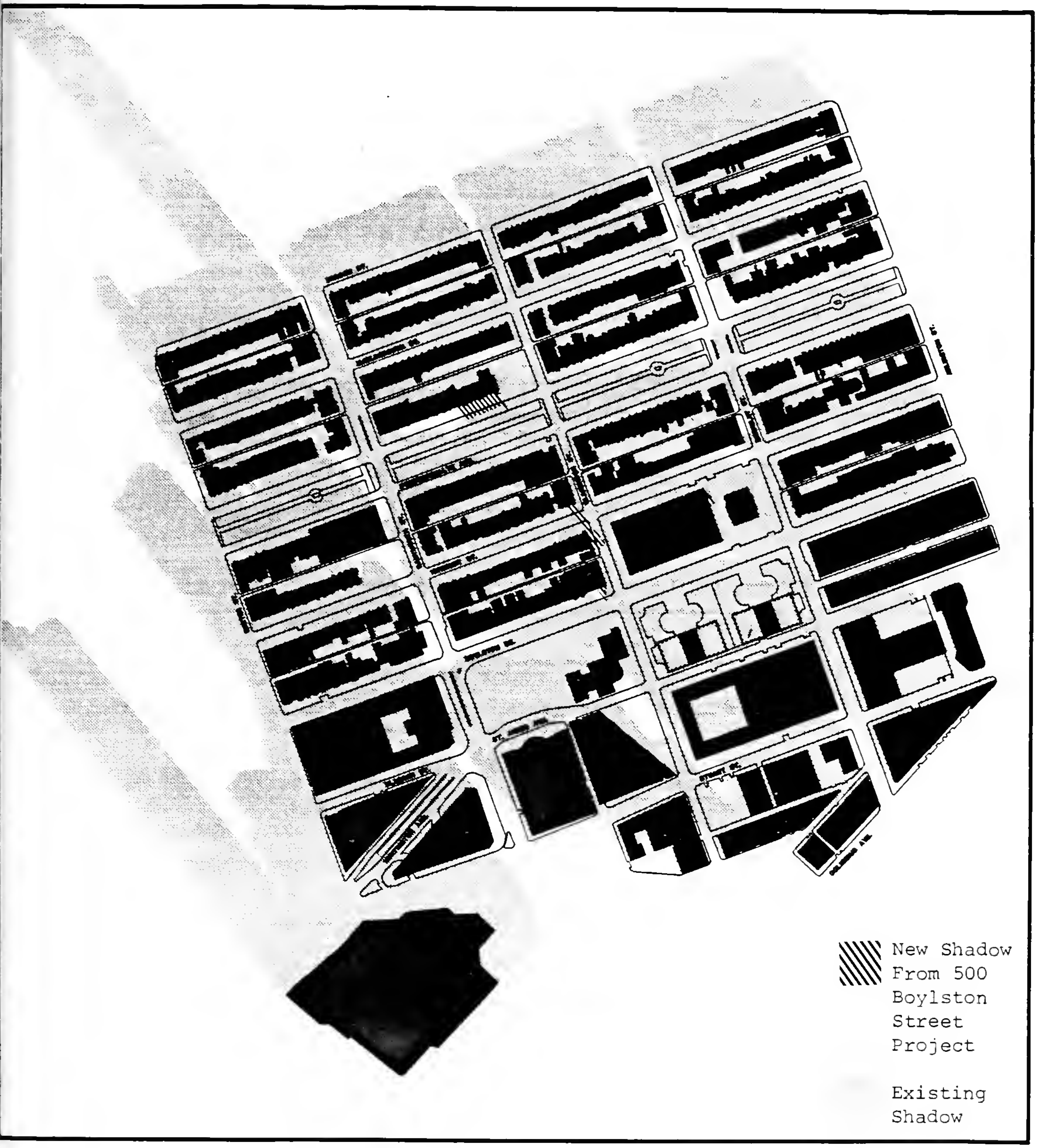


EXHIBIT IV-25
(Continued)

Winter Solstice
December 21, 12:00 Noon

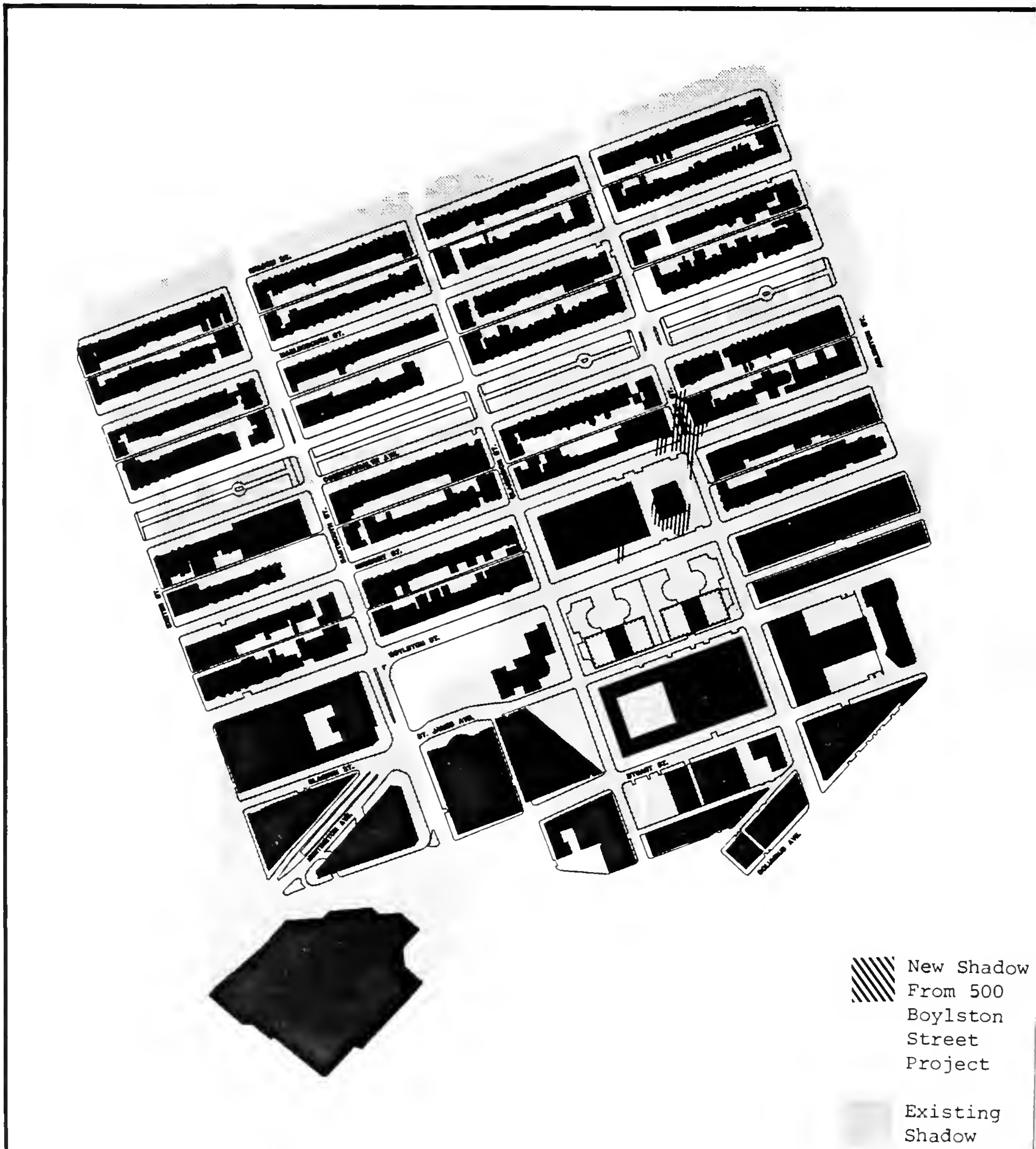
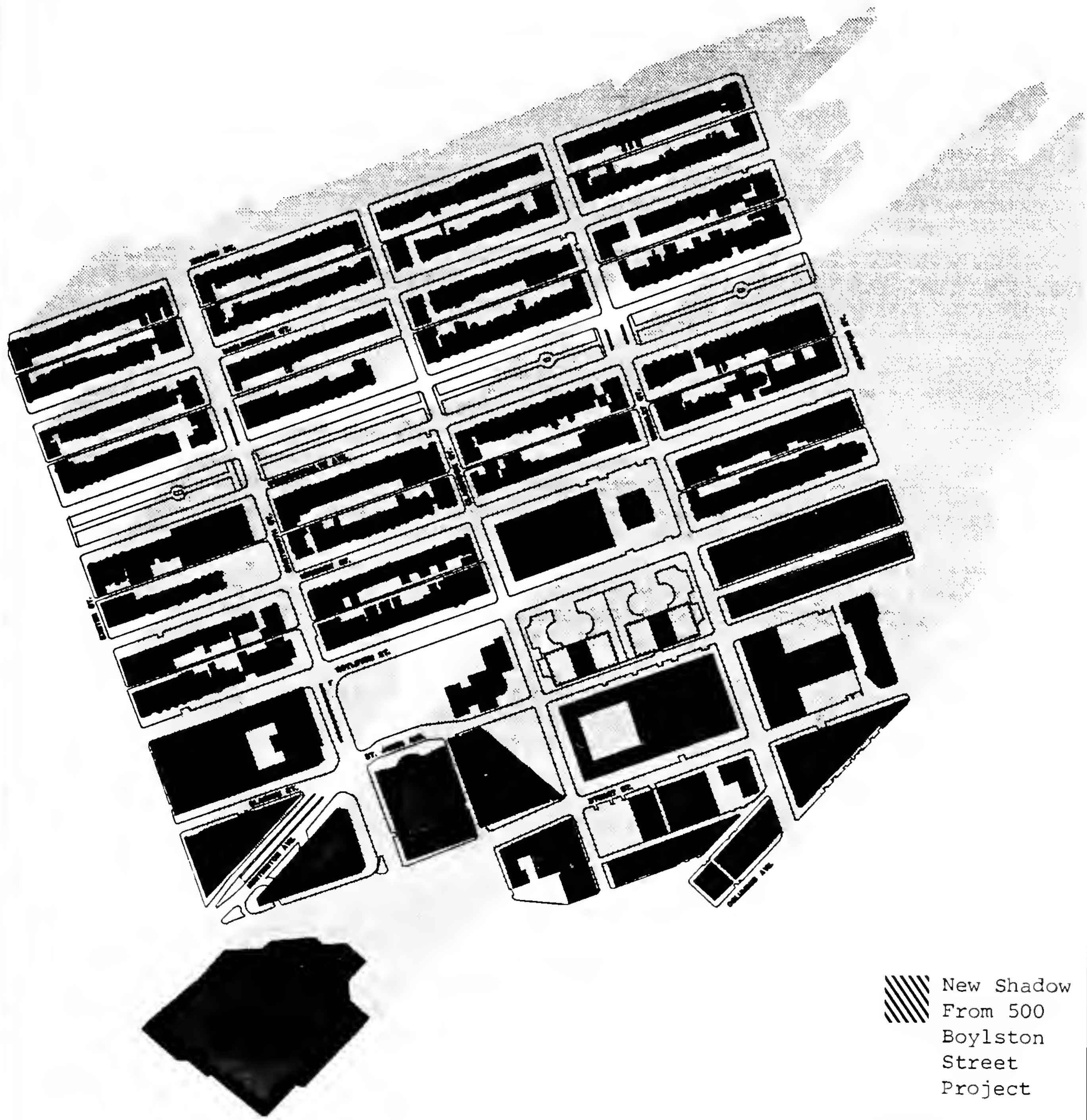


EXHIBIT IV-26
(Continued)

Winter Solstice
December 21, 3:00 PM



New Shadow From 500 Boylston Street Project

Existing Shadow

buildings in the Back Bay area and the incremental shadows cast by the 500 Boylston Street Project. It does not consider the extensive shadows cast by the mature trees on the Commonwealth Avenue Mall, nor does it consider shadows cast by trees and structures on the playground itself. The 133 shadow diagrams that comprise the data for the Clarendon Street Playground are presented in Technical Appendix 4, which accompanies this BRA Final EIR.

The results of the additional technical studies conducted after submission of the BRA Draft EIR are presented in the following section as responses to the two BRA comments on the Draft EIR shadow analysis.

COMMENT 58:

[Ref. Figures IV-34, 35, and 36, BRA Draft EIR] The shadow diagrams, while very useful in distinguishing shadows cast by the project from those cast by existing buildings lack a distinction in the overlapping situation, i.e., one cannot readily distinguish where the project shadow is a new shadow and where it overlaps an existing shadow.

RESPONSE:

Exhibits IV-24, 25, and 26 depict the existing Back Bay shadow conditions and the new, incremental shadows cast by the 500 Boylston Street Project. These figures incorporate the refinements in precision discussed above. The impact assessment presented in the Draft EIR remains unchanged for the Vernal and Autumnal Equinoxes (March 21, October 21) and for the Summer Solstice (June 21). At the Winter Solstice, shadows would occur as described in the Draft EIR, with the following amplifications:

o <u>Copley Square</u>. During the very early spring, summer, and fall morning hours, the proposed project will cast new shadows on the northeast corner of Copley Square. Project shadows will not affect the square at other times of the day.

o <u>Commonwealth Avenue Mall</u>. The north side of Commonwealth Avenue Mall will be affected by new project shadows during the morning hours on portions of the blocks between Berkeley and Dartmouth Streets. As noted in the Draft EIR,

there is extensive coverage of this area from existing shadows created by the New England Life Building at 501 Boylston Street, the John Hancock towers, and buildings on the south side of Commonwealth Avenue.

- <u>Clarendon Street Playground</u>. Currently, the New England Life Building at 501 Boylston Street, the John Hancock Berkeley Building, the First Baptist Church, and #90 Commonwealth Avenue (at the corner of Commonwealth Avenue and Clarendon Street) cast shadows on the Clarendon Street Playground for almost an hour and a quarter in the morning on December 21, from approximately 7:45 AM until after 9:00 AM. The 500 Boylston Street Project would prolong shadow coverage on the playground until approximately 9:40 AM.

- <u>Summary</u>. The Boylston Street pedestrian and retail area will experience a small increment of new morning and afternoon shadow in the fall, winter, and spring as a result of the proposed project. Copley Square will experience a small increase of shadow coverage in the early morning hours during spring, summer, and fall months. During winter mornings, new shadows will be cast on the north side of Commonwealth Avenue. New shadows cast by the proposed project on the Clarendon Street Playground will occur in the late fall, as well as during the winter months. Partial shading of the playground during this period will occur for a duration of less than 15 minutes to more than 45 minutes between 8:00 AM and 9:45 AM. (See Response to Comment 59.) The 500 Boylston Street open space plazas will be in direct sunlight during summer afternoons, but will be in shadow for the rest of the year.

COMMENT 59:

In addition, the shadow diagrams are inaccurate, particularly as they relate to the Clarendon Street Playground and the Commonwealth Avenue Mall, since apparently the correct time for Boston within the time zone was not used. Adjustments should be made in the Final EIR and accurate studies presented.

RESPONSE:

The shadow analysis for the Clarendon Street Playground was prepared subsequent to the submission of the BRA Draft EIR. Results of this study are described below. Technical Appendix 4 of this BRA Final EIR contains the 133 shadow diagrams and site plan for the playground that comprise the data upon which the impact assessment was based.

Clarendon Street Playground

During the fall, winter and spring, existing buildings in the Back Bay cast a complete or partial shadow on the Clarendon Street Playground throughout portions of the morning and afternoon. During the summer, buildings adjacent to the playground shade it during afternoon hours.

The new incremental shadows cast by the proposed 500 Boylston Street project will occur during the period late October through early February. The rest of the year, the playground will not experience any shadow coverage due to the project. During the late fall and winter period, the proposed project will partially shade the playground for a duration of less than 15 minutes to more than 45 minutes between 8:00 AM and 9:45 AM. In most instances, this partial shading amounts to less than approximately 25 percent coverage of the playground area. In the worst case scenario (early December to mid-January) the incremental shadow will cover up to 75 percent to 80 percent of the playground during the early morning hours. The net effect of the project is to extend the duration of existing shadow coverage or to "fill in the gaps" between existing shadows. In some instances, this net effect amounts to only shadow coverage of a small percentage of the total area of the playground, yet it can be the difference between partial shading and total shading.

This analysis does not formally address the shading effects of trees on or near the playground, however, these effects can be significant. In particular, the large trees on Commonwealth Avenue and on the Commonwealth Avenue Mall cast extensive shadows on the playground during all seasons of the year, even after leaves have dropped.

STATUS REPORT

The BRA Draft EIR reported the possibility that remains of a prehistoric fishweir may exist at the 500 Boylston Street Project site based on previous discoveries during the construction of the New England Life headquarters at 501 Boylston Street and the John Hancock Berkeley Building. As indicated in Appendix 5 of the Draft EIR, the City archaeologist and the proponent are making progress toward finalizing a cooperative agreement for the archaeological investigation of the site. The first phases of the reconnaissance effort have begun. In December 1984, two 2-1/2 inch split spoon cores were recovered from Providence Street and are currently undergoing analysis at Brown University. The results of these laboratory analyses will be evaluated by the senior archaeologists advising the City of Boston and the proponent during February 1985. Library research on coastal fishweirs has been underway since December 1984. An interim status report concerning these reconnaissance efforts is included in this Final EIR as Technical Appendix 5.

Following the analysis of the core, the archaeologists, with continued support from the proponent, will undertake the remaining phases of the reconnaissance effort, including: evaluation of alternative project construction scenarios as they relate to the archaeological resource recovery effort, and conclusions and recommendations constituting a detailed research design work program and data recovery program. Depending on the results of the reconaissance work, five major research topics may be addressed in the archaeological investigations of the Boylston Street Fishweir: (i) the number of construction or repair episodes; (ii) the form of the structure or structures; (iii) the age and duration of the structure(s); (iv) the function of the structure(s); and (v) the labor investment in the construction. The archaeological research program will be designed to meet the scientific standards of the City of Boston and the Massachusetts Historical Commission.

V Measures to Mitigate Adverse Effects

Mitigation measures proposed to minimize the potential adverse effects of the 500 Boylston Street Project are summarized in this Chapter. The implementation of some of these measures would require actions by public agencies. In such cases, the proponent is committed to working cooperatively to achieve these objectives.

'RANSPORTATION

- Encourage vanpool and carpool programs and mass transit ridership to reduce vehicle trips.
- Work cooperatively with the City of Boston in the installation of intersection improvements and the enforcement of peak hour parking restrictions at Beacon/Berkeley, Boylston/Berkeley, and Arlington/Stuart/Columbus to improve traffic flow and level of service.
- Investigate re-reversal of Charles Street traffic direction and use of new directional signage in the Back Bay to improve arterial flows at peak hour traffic periods.
- Investigate reversing the westbound flow on Marlborough Street between Berkeley and Arlington Streets back to eastbound as it used to be.
- Encourage the responsible public agencies to implement a computer-based traffic signal control system in the Back Bay according to the City of Boston's plan.
- Design and manage off-street parking facilities to provide for smooth operations and to discourage excessive parking demand.
- Cooperate with the City of Boston in the adjustment of on-street parking restrictions and increase enforcement of these restrictions to improve roadway capacity at peak hours.
- Consider implementation of peak period restrictions on truck deliveries.

AIR QUALITY

- Encourage the elimination of parking from the west side of Arlington Street between St. James Avenue and Columbus Avenue.
- Encourage the adjustment of traffic signal timing for off-peak periods at Berkeley/Boylston, Berkeley/St. James and Berkeley/Columbus intersections to reduce queuing delays for northbound traffic on Berkeley Street.
- Advocate the continuation of the State Inspection and Maintenance Program.
- Utilize site wetting to minimize fugitive dust emissions during construction.

NATURAL RESOURCES

- Design foundations and lateral earth support systems to minimize ground movement and groundwater infiltration.
- Establish construction performance criteria and a construction monitoring program that includes a sewer monitoring plan.
- Monitor groundwater levels at the site for one year prior to construction, and implement remedial measures (as needed) during construction to maintain groundwater at acceptable levels.
- Consider long-term system for recharging groundwater, if needed.

HISTORIC/VISUAL QUALITY

- Continue the public design review process with the St. James Civic Advisory Committee in conjunction with other local and state agency reviews.

WIND

- Implement tree configuration #1 as a wind mitigation measure. As a result, no station will exceed the BRA Guideline defined as effective gust speeds of 31 mph, no greater than one percent of the time (speeds in excess of 31 mph are acceptable if they are the same or lower than existing conditions).

- Investigate the implementation of further tree configuration #2, to mitigate adverse wind conditions in the St. James Avenue/Clarendon Street area.

SHADOW

- No significant adverse impacts anticipated based on a computer analysis.

ARCHAEOLOGY

- Investigate, document and recover archaeological resources associated with the Boylston Street Fish Weir, if present.
- Coordinate research efforts with the City of Boston Department of the Environment and the Massachusetts Historical Commission.

Appendix 1

Environmental Notification Form Including Scope Statement for the BRA EIR

The Environmental Notification Form included on the following pages was filed with the MEPA Unit of the Massachusetts Executive Office of Environmental Affairs and noticed in the Environmental Monitor on June 6, 1984.

At the state level, the Secretary of EOEA required an EIR on sewerage impacts. At the city level, the BRA requested a broadly scoped EIR that covered the impact categories (see Attachment 2 of the ENF).

APPENDIX A
COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

ENVIRONMENTAL NOTIFICATION FORM

I. SUMMARY

A. Project Identification

1. Project Name 500 Boylston Street

2. Project Proponent Address A joint venture of New England Mutual Life Insurance Company and Gerald D. Hines Interests, Inc., 535 Boylston Street, Boston, MA 02116

B. Project Description: (City/Town(s) Boston

1. Location within city/town or street address Parcel bounded by Clarendon, Boylston, and Berkeley Streets and St. James Avenue.

2. Est. Commencement Date: 1st Quarter 1985 **Est. Completion Date:** 1st Quarter 1989

Approx. Cost $ $288 million **Current Status of Project Design:** 30 **% Complete**

C. Narrative Summary of Project

The 500 Boylston Street project will establish an active mixed-use development consisting of offices, general retail stores, restaurants, other commercial uses, pedestrian plazas and walkways, and a below-grade garage. In the heart of Boston's Back Bay, the 3.15-acre parcel on which the proposed project will be sited is bordered by St. James Avenue and Clarendon, Boylston, and Berkeley Streets. New England Mutual Life Insurance Company and Gerald D. Hines Interests, Inc. (together referred to as the Joint Venture) are the proposed developer.

The overall design and program of uses submitted for MEPA review have been subject to an extensive public participation process. In November 1982, the Boston Redevelopment Authority (BRA) authorized an advertisement for development interest in the St. James Garage site. The Joint Venture was the only developer to respond with a proposal. The BRA subsequently invited local residents as well as business and cultural leaders to participate in the review of the development proposal through the St. James Civic Advisory Committee (CAC). A list of the membership of this CAC is presented in Attachment 1. Over the year, this CAC, representing the Back Bay and the South End, worked closely with the Joint Venture. This process resulted in design modifications by the developers. On December 8, 1983, following the determination that the proposal met the BRA's and CAC's initial guidelines, the BRA tentatively designated the Joint Venture as developer of the St. James Garage site.

Presently, the site consists of office and retail uses, primarily fronting on Boylston Street between Berkeley and Clarendon; a portion of Providence Street; and the city-owned, 625-car St. James Garage. New England Life owns the buildings on the south side of Boylston Street and will acquire the St. James Garage and adjacent Providence Street in order to implement the full-block master plan for the site. This plan will enable the corporate expansion of New England Life to occur across the street from its present headquarters.

The proposed project will include:

o	Retail uses (including restaurants)	± 100,000 square feet
o	Office uses	± 1,200,000 square feet
		± 1,300,000 square feet
o	Subsurface parking (on site)	± 1,000 spaces

Copies of this may be obtained from:
Name: Rebecca Packard Firm/Agency: Skidmore, Owings & Merrill
Address: 334 Boylston Street, Boston, MA 02116 Phone No. (617) 247-1070

:979 THIS IS AN IMPORTANT NOTICE. COMMENT PERIOD IS LIMITED.
For Information, call (617) 727-5830

The 1.2 million square feet of office space will be primarily located in two towers, rising 19 stories above a 6-story base (maximum project height is 25 stories). The towers are situated to the rear of the site along the St. James Avenue boundary. Portions of the office use are also located in the upper floors of this 6-story base structure. Approximately 100,000 square feet of retail/commercial use will be contained in the first two levels of the 6-story structure. Approximately 1,000 on-site parking spaces will be provided below grade, of which 625 spaces will be designated for public use. Service and parking entrance and exit to the site will be from St. James Avenue, Berkeley Street, and Clarendon Street. Pedestrian open areas will include the sidewalk and two open plazas on Boylston Street. These plazas will be lined with active retail uses and will provide an open plaza entry to portions of the office structure.

The Joint Venture has already initiated a number of environmental studies as part of the public review process established with the CAC. To date, this work has included wind tunnel, transportation and parking, and geotechnical studies in order to identify potential project impacts.

The project is categorically included under Class D(a) of Appendix C of the MEPA Regulations. The only State permits required for the project are sewer permits from the DWPC and MDC. In accordance with the MEPA statute, M.G.L. c. 30, Sections 61-62H, which provides at Section 62A that the scope of an EIR is "limited to that part of the project which is within the subject matter jurisdiction of the [State] permit," the scope of the EIR for the project will be limited to a discussion of sewer impacts. The proponent has agreed to prepare a broadly scoped environmental impact review discussing the impacts of the project on wind, shadow, transportation, air quality, and historical, archaeological and geotechnical/sewerage resources which will be subjected to critical review by the BRA and the CAC, which represents major Back Bay and South End neighborhood and business groups. A summary of the studies to be conducted in connection with the proposed environmental impact review is attached hereto as Attachment 2. The proponent requests a waiver of the requirement of filing an EIR for the project on the basis that the studies to be conducted by the proponent for the BRA and the CAC will serve to minimize damage to the environment from the project to a greater extent than could be achieved by any agency after preparation of an EIR on sewerage impacts.

This project is one which is categorically included and therefore automatically requires preparation of an Environmental Impact Report: YES X NO ____

D. Scoping (Complete Sections II and III first, before completing this section.)

1. Check those areas which would be important to examine in the event that an EIR is required for this project. This information is important so that significant areas of concern can be identified as early as possible, in order to expedite analysis and review.

	Construction Impacts	Long Term Impacts		Construction Impacts	Long Term Impacts
Open Space & Recreation			Mineral Resources		
Historical		X	Energy Use		X
Archaeological		X	Water Supply & Use		X
Fisheries & Wildlife			Water Pollution		
Vegetation, Trees			Air Pollution	X	X
Other Biological Systems			Noise	X	X
Inland Wetlands			Traffic		X
Coastal Wetlands or Beaches			Solid Waste	X	X
Flood Hazard Areas			Aesthetics		X
Chemicals, Hazardous Substances, High Risk Operations	X		Wind and Shadow		X
Geologically Unstable Areas	X		Growth Impacts		X
Agricultural Land			Community/Housing and the Built Environment		X
Other (Specify)					

2. List the alternatives which you would consider to be feasible in the event an EIR is required.

A "No Build" alternative, continuing the existing use, will be included as a base for comparing project impacts.

E. Has this project been filed with EOEA before? Yes _____ No X
If Yes, EOEA No. ________ EOEA Action? ________

F. Does this project fall under the jurisdiction of NEPA? Yes _____ No X
If Yes, which Federal Agency? ________ NEPA Status? ________

G. List the State or Federal agencies from which permits will be sought:

Agency Name	Type of Permit
Mass. Department of Environmental Quality Engineering	Sewer Extension Permit (Ch. 21, S.43)
Mass. Historical Commission	Determination of Effect to Historic Properties.[1]
Metropolitan District Commission	Industrial User Discharge Permit (MGL Ch.92, S1-8A).

[1] Although this determination will be required for the project, it is the view of the proponent and EOEA that such determination does not constitute a state permit under MEPA.

H. Will an Order of Conditions be required under the provisions of the Wetlands Protection Act (Chap. 131, Section 40)?
Yes _____ No X
DEQE File No., if applicable: ________

I. List the agencies from which the proponent will seek financial assistance for this project:

Agency Name	Funding Amount
None.	

II. PROJECT DESCRIPTION

A. Include an original 8½ x 11 inch or larger section of the most recent U.S.G.S. 1:24,000 scale topographic map with the project area location and boundaries clearly shown. Include multiple maps if necessary for large projects. Include other maps, diagrams or aerial photos if the project cannot be clearly shown at U.S.G.S. scale. If available, attach a plan sketch of the proposed project. (Attached)

B. State total area of project: 137,074 square feet (± 3.15 acres)
Estimate the number of acres (to the nearest 1/10 acre) directly affected that are currently:

1. Developed .... 3.15 acres
2. Open Space/Woodlands/Recreation ____ acres
3. Wetlands .... ____ acres
4. Floodplain .... ____ acres
5. Coastal Area .... ____ acres
6. Productive Resources
   - Agriculture .... ____ acres
   - Forestry .... ____ acres
   - Mineral Products .... ____ acres

C. Provide the following dimensions, if applicable:
Length in miles _____ Number of Housing Units _____ Number of Stories 6 to 25

	Existing[2]	Immediate Increase Due to Project[2]
Number of Parking Spaces[3] . . (on-site)	625	375
Vehicle Trips to Project Site (average daily traffic)	1,700	3,340[4]
Estimated Vehicle Trips past project site		
Clarendon Street	10,000	1,000
Boylston Street	18,900	500
Berkeley Street	19,400	600
St. James Avenue	11,900	1,800

For footnotes 2, 3, and 4 see following page.

D. If the proposed project will require any permit for access to local or state highways, please attach a sketch showing the location of the proposed driveway(s) in relation to the highway and to the general development plan; identifying all local and state highways abutting the development site; and indicating the number of lanes, pavement width, median strips and adjacent driveways on each abutting highway; and indicating the distance to the nearest intersection. (Not applicable)

II.C. (cont'd)

Footnotes

2 Based on "Transportation Impact Study, Proposed St. James Development, Boston, Massachusetts." Prepared for New England Life/ Gerald D. Hines Interests. Vanasse/Hangen Associates, Inc., Boston, MA, June 1983.

3 The project proponents are analyzing various alternatives for expanding the capacity of the National Garage on Dartmouth Street near Columbus Avenue. The garage, controlled by New England Life, currently contains approximately 520 spaces. Up to 300 additional stalls could be provided if approved by the City of Boston and if study findings indicate it is feasible to recondition, modernize, and/or expand this facility. During construction, these spaces would be available for public monthly parking and afterwards for tenant parking. As a consequence, the short-term loss of the St. James Garage spaces would be eased.

4 To estimate future travel characteristics, person trip rates and mode splits were derived from recent local traffic studies and neighboring insurance companies' transportation surveys. From this information, transportation mode splits were identified for work and non-work trips to the office and retail components of the project. These mode-split percentages are shown below.

Trip Distribution:

USE	VEHICLE (Autos/Carpools)	TRANSIT	WALKING
OFFICE			
Work	37%	56%	7%
Non-Work	45%	40%	15%
RETAIL			
Work	30%	60%	10%
Non-Work	40%	20%	40%

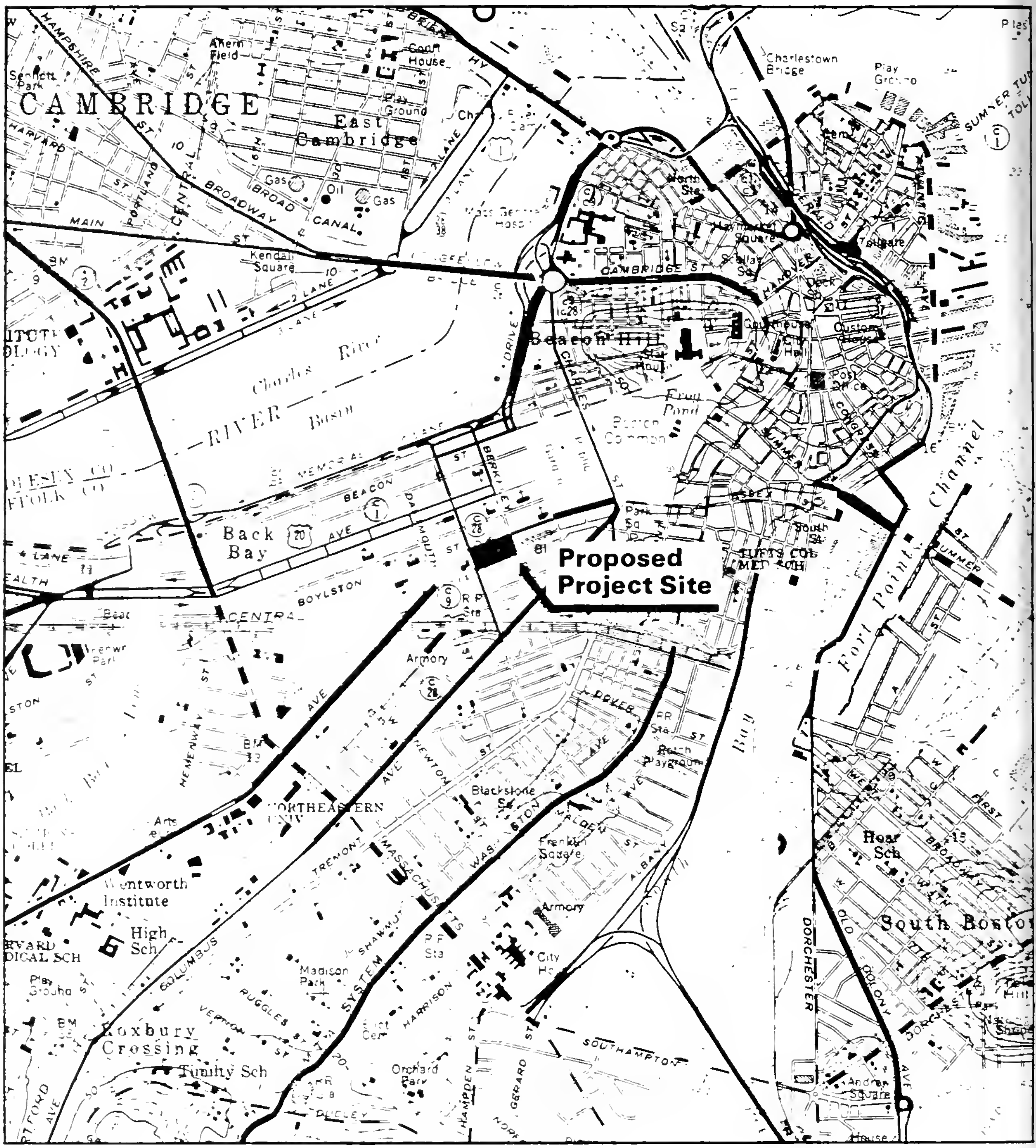
At full development, the project site will generate 3,340 new vehicle trips on an average weekday, with 1,670 vehicle trips each entering and exiting the site. During the AM peak hour, 577 new vehicle trips are expected and during the PM peak, 659 new vehicle trips are expected.

Based on area roadway patterns, the distribution of new vehicle trips to and from the site is expected to generally occur as follows:

- To and from the north - 16%
- To and from the south - 20%
- To and from the east - 24%
- To and from the west - 40%

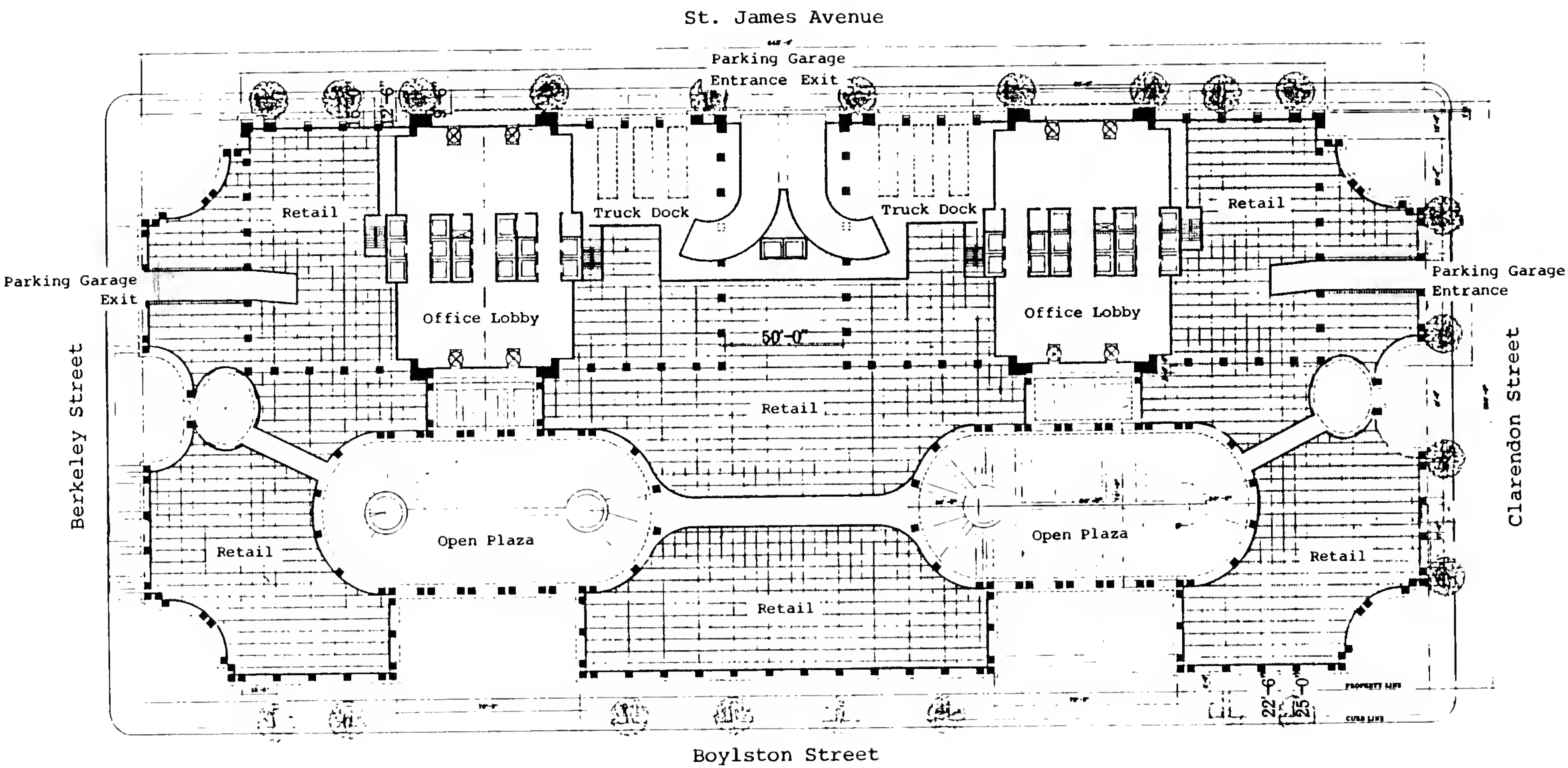
Locus Map

500 Boylston Street
Boston, Massachusetts



Scale 1:24,000

(Parcel is bounded by Clarendon, Boylston, and Berkeley Streets and St. James Avenue)



Ground Floor Plan

A New England Life/Gerald D. Hines Project
John Burgee Architects with Philip Johnson

III. ASSESSMENT OF POTENTIAL ADVERSE ENVIRONMENTAL IMPACTS

Unless otherwise stated, the following information is based on technical analyses conducted by Skidmore, Owings, & Merrill; Vanasse/Hangen Associates, Inc.; the Wright Brothers Facility of the Massachusetts Institute of Technology; Haley & Aldrich Inc.; and LeMessurier Associates/SCI.

A. Open Space and Recreation

1. Might the project affect the condition, use or access to any open space and/or recreation area?
Yes _____ No _X_

The existing 26,400 square feet of pedestrian open space will be more than doubled by the proposed project. The development's open areas include a pedestrian walkway and two plazas on Boylston Street, widened walkways on Clarendon Streets and St. James Avenue, and perimeter landscaping around the entire block. Nearby open space/recreation areas include Copley Square, the Public Garden, the linear park down Commonwealth Avenue, and a "tot lot" on the corner of Commonwealth Avenue and Clarendon Street. While the tot lot may have some additional shadow cast on it for 45 minutes during a 30-day period primarily in December, no significant adverse effects are expected on the lot or other nearby open spaces.

B. Historic Resources

1. Might any site or structure of historic significance be affected by the project? Yes _X_ No _____

Explanation and Source:

The proposed project site contains no historically significant structures. However, one-half of the site, from Boylston Street to Providence Street, falls within the Back Bay Historic District, as listed in the National Register. Nearby individual National Register historic properties, some of which are also designated by the Boston Landmarks Commission, include Trinity Church, the Boston Public Library, Old South Church, Trinity Rectory, First Baptist Church, Arlington Street Church, Commonwealth Avenue Mall, and Crownshield House. The design of the proposed complex was developed with an awareness of the historic location and with particular attention to the view of Trinity Church and the Boston Public Library. The proposed office towers, therefore, are set back substantially on the site, and the six-story platform structure fronting Boylston Street relates to the scale of the area and takes into account pedestrian vistas. The complex also presents cornice lines and materials in keeping with surrounding buildings and a broken facade to preserve retail identity.

2. Might any archaeological site be affected by the project? Yes _X_ No _____

Explanation and Source:

The city and state archaeologists believe that the Boylston Street Fishweir, portions of which were discovered during the excavations for the existing New England Mutual Life Building and the original John Hancock Building, will also be present in the marine deposits of the proposed project site. With the cooperation of New England Life, a detailed archaeological field investigation was conducted during the 1936 excavation for the headquarters at 501 Boylston Street. Data analyzed for this study suggested that the weir was at least 6,000 years old and indicated technical sophistication not usually attributed to aborigines of that period. Discussions are underway with the City of Boston archaeologist to ascertain the likelihood of intact portions being in existence on the project site, in view of extensive site development during the 1950s, and to determine how to proceed.

C. Ecological Effects

1. Might the project significantly affect fisheries or wildlife, especially any rare or endangered species?
Yes _____ No _X_

Explanation and Source:

The project site, currently occupied by commercial buildings and a parking garage, is located within a densely developed urban area supporting no fisheries, wildlife, or endangered species.

2. **Might the project significantly affect vegetation, especially any rare or endangered species of plant?**
Yes _____ No _X_
(Estimate approximate number of mature trees to be removed: __________)
Explanation and Source:

The project site contains no significant vegetation. Although project development will cause some dust during construction, the impact on vegetation will be minor and temporary.

3. **Might the project alter or affect flood hazard areas, inland or coastal wetlands (e.g., estuaries, marshes, sand dunes and beaches, ponds, streams, rivers, fish runs, or shellfish beds)? Yes _____ No _X_**
Explanation and Source:

According to the Federal Emergency Management Agency Flood Insurance Rate Map (Community-Panel #250286 0010C, April 1, 1982), the project area is not within a flood-hazard zone. No inland or coastal wetlands exist within the site vicinity.

4. **Might the project affect shoreline erosion or accretion at the project site, downstream or in nearby coastal areas? Yes _____ No _X_**
Explanation and Source:

The project site is not in the immediate vicinity of any shoreline or coastal area.

5. **Might the project involve other geologically unstable areas? Yes _X_ No _____**

Haley and Aldrich Inc. has provided preliminary information[5] on the geotechnical aspects of the proposed project based on subsoil and groundwater studies carried out over the past fifty years in the Back Bay. The general soil profile of the area from the ground surface downward includes: miscellaneous man-placed fill, organic deposits, outwash deposits, marine deposits, glacial till, and bedrock. Groundwater levels are normally in the range of El. 5 to 8. Available test boring information indicates that soil and groundwater conditions at the site are typical of the area, though it appears that the outwash sand stratum is not present between the organic deposits and the marine clay. It is anticipated that a lateral earth support system consisting of internally braced steel sheet piling and/or slurry walls will be used for the proposed project. This type of braced earth support system and appropriate construction procedures, as used at many other sites in Boston, should prevent significant ground movement or other adverse effects.[6]

For footnotes 5 and 6 see following page.

D. Hazardous Substances

1. **Might the project involve the use, transportation, storage, release, or disposal of potentially hazardous substances?**
Yes _X_ No _____

Project construction (but not subsequent operation) will require the use of potentially hazardous materials including oil-based substances for equipment maintenance and entrainment fluids for use in concrete mixing as per construction practices. Currently it is not known if asbestos is present in any of the buildings slated for demolition. If asbestos is found following site inspection, a removal plan will be formulated in accordance with approved practices and applicable regulations. The project includes only nonindustrial commercial development (offices, stores, and parking) in which potentially hazardous substances will not be used other than normal fuel storage in automobiles in the garage and in the project's emergency generator.

III.C.5. (cont'd)

Footnotes

5 See "Preliminary Report on Geotechnical Aspects of Foundation Construction, Proposed NEML/Gerald D. Hines Development, Boylston and Clarendon Streets, Boston, Mass." Haley and Aldrich, Inc., Cambridge, MA, May 1983.

6 LeMessurier Associates, structural and foundation consultants, also reviewed potential construction procedures for this site and concluded that the proposed 500 Boylston Street building can be built without jeopardizing adjoining sites. They have demonstrated that requirements of deep excavation, control of groundwater, lateral support of adjoining areas, and the driving of long piles have been successfully satisfied in other projects subject to more difficult circumstances. (Source: Correspondence, William J. LeMessurier, LeMessurier Associates, to E. Staman Ogilvie, Gerald D. Hines Interests, May 18, 1983.)

E. Resource Conservation and Use

1. Might the project affect or eliminate land suitable for agricultural or forestry production?
Yes ______ No __X__
(Describe any present agricultural land use and farm units affected.)

Explanation and Source:

The project site is located within a densely-developed urban area supporting neither agricultural nor forestry production. The site is not suitable for agricultural use.

2. Might the project directly affect the potential use or extraction of mineral or energy resources (e.g., oil, coal, sand & gravel, ores)? Yes ______ No __X__

Explanation and Source:

No mineral or energy resources are known to exist on site.

3. Might the operation of the project result in any increased consumption of energy? Yes __X__ No ______

The proposed project will result in increased energy consumption. Arrangements with the electrical power utility, Boston Edison, will be made to insure the supply of sufficient power and that existing equipment is compatible with the development. Building design standards for insulation and other energy-related features will ensure efficient energy use. Construction will meet all applicable codes, including requirements of Article 20 (Energy) of the Massachusetts State Building Code.

F. Water Quality and Quantity

1. Might the project result in significant changes in drainage patterns? Yes ______ No __X__

Explanation and Source:

The project area is entirely impervious and drains into the city's stormwater system. The proposed structures will not significantly alter this pattern.

2. Might the project result in the introduction of pollutants into any of the following:

(a) Marine Waters	Yes ______	No __X__
(b) Surface Fresh Water Body	Yes ______	No __X__
(c) Ground Water	Yes ______	No __X__

Explain types and quantities of pollutants.

No pollutants.

3. Will the project generate sanitary sewage? Yes __X__ No ____

If Yes, Quantity: __115,000__ gallons per day [7]

Disposal by: (a) Onsite septic systems .... Yes ____ No __X__

(b) Public sewerage systems .... Yes __X__ No ____

(c) Other means (describe) ______________________________

7 Based on sewage flow estimates listed in DEQE 310 CMR 15.02 (State Environmental Code, Title 5).

4. Might the project result in an increase in paved or impervious surface over an aquifer recognized as an important present or future source of water supply? Yes ____ No __X__

Explanation and Source:

The aquifer underlying Boston is not recognized as an important present or future source of water supply.

5. Is the project in the watershed of any surface water body used as a drinking water supply?
Yes ____ No __X__

Are there any public or private drinking water wells within a 1/2-mile radius of the proposed project?
Yes ____ No __X__

Explanation and Source:

According to the Boston Water and Sewer Commission, there are no known water supplies as described above. Drinking water is supplied via the Boston water distribution system, which is served by the Metropolitan District Commission.

6. Might the operation of the project result in any increased consumption of water? Yes __X__ No ____

Approximate consumption __132,250__ [8] gallons per day. Likely water source(s) __Boston Water and Sewer Commission__

8 Based on sewage flow estimates listed in DEQE 310 CMR 15.02 (State Environmental Code, Title 5), plus 15%.

7. Does the project involve any dredging? Yes ____ No __X__

If Yes, indicate:

Quantity of material to be dredged ______________________________

Quality of material to be dredged ______________________________

Proposed method of dredging ______________________________

Proposed disposal sites ______________________________

Proposed season of year for dredging ______________________________

Explanation and Source:

G. Air Quality

1. Might the project affect the air quality in the project area or the immediately adjacent area?
Yes X No ____

Describe type and source of any pollution emission from the project site.

Some air pollution will be generated by the project. Increased numbers of vehicles visiting the site and using the underground parking garage will contribute to air pollution in the area. Emission vents for the garage will be located to minimize any adverse environmental impacts related to pedestrian areas or air intakes for nearby buildings. Short-term air quality impacts from fugitive dust will occur during construction. In addition, there is the possibility that asbestos exists in some of the buildings slated for demolition. If further research indicates asbestos, a removal plan will be formulated and there will be compliance with all applicable DEQE regulations.

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any pollution emissions caused by the project, including construction dust? Yes X No ____

Explanation and Source:

Sensitive receptors in the area include public and pedestrian spaces at nearby intersections, such as Copley Square, and adjacent building air intakes.

3. Will access to the project area be primarily by automobile? Yes ____ No X

Describe any special provisions now planned for pedestrian access, carpooling, buses and other mass transit.

According to Vanasse/Hangen's recent study of the proposed project's transportation impacts,[9] the majority (60 percent) of new person-trips to the site will be by transit or by walking. The remaining 40 percent of the daily trips will be by personal car, carpool/vanpool, or taxi.

Public transit service to the area currently consists of express buses, commuter rail to the Back Bay Station, and light rail rapid transit (the Green Line). The relocation of the Orange Line to the Back Bay Station will make this station a major regional transportation hub. Furthermore, the expanded capacities of the Orange and Green Lines in the future are expected to result in a transit capacity surplus for the Back Bay, fostering mode shifts to transit from private vehicles. In addition, New England Life will continue to operate its vanpool program.

---

9 Transportation Impact Study, Proposed St. James Development, Boston, Massachusetts." Prepared for New England Life/Gerald D. Hines Interests. Vanasse/Hangen Associates, Inc., Boston, MA, June 1983.

H. Noise

1. Might the project result in the generation of noise? Yes X No ____

Noise will be generated during the demolition/construction phase, over the short-term. All demolition/construction practices will be in compliance with 310 CMR 7.10, to minimize adverse noise impacts. Long-term noise effects will result from increased vehicular activity at the site after its completion.

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any noise caused by the project? Yes X No ____

Explanation and Source:

Sensitive receptors in the area include Trinity Church, pedestrian walkways, public open areas, such as Copley Square, and adjacent buildings.

I. **Solid Waste**

1. **Might the project generate solid waste? Yes __X__ No ____**

Explanation and Source:

The project will generate approximately 9,000 tons of solid waste per year.[10] Types of waste will include paper goods, food service wastes, bottles, cans, and boxes and cartons. Disposal of this waste will be handled through a contract disposal service. Construction debris disposal will be the responsibility of the developer and contractors.

[10] Based on general standards derived from A Primer on Industrial Environment Impact, Michael R. Greenberg, et. al., Rutgers Center for Urban Policy Research, 1979, and checked with DEQE.

J. **Aesthetics**

1. **Might the project cause a change in the visual character of the project area or its environs? Yes __X__ No ____**

The proposed project will alter the visual character of the project area. Presently, office and retail uses are contained within several low-rise structures primarily fronting on Boylston Street, and parking is provided within a deteriorating parking garage on St. James Avenue. The development proposal will continue this mixture of uses, but replace the existing buildings with an integrated, mixed-use development based on a comprehensive master plan for the entire block. This development will consist of a six-story structure, covering the entire project site, with twin office towers set back along St. James Avenue. In keeping with the pedestrian character of this area, wide sidewalks and two plazas will be provided along Boylston Street. The proposed office towers are set back on the site, and the six-story retail/office platform structure relates to the scale of the area and takes into account pedestrian vistas. The project's cornice lines and materials are in keeping with surrounding buildings, and the broken facade preserves retail identity. The public participation process, established for this project with the Civic Advisory Committee, initially focused on the review of the overall design concept and resulted in design modifications. The second phase of this participation process is primarily concerned with design details of the proposed project.

2. **Are there any proposed structures which might be considered incompatible with existing adjacent structures in the vicinity in terms of size, physical proportion and scale, or significant differences in land use? Yes ____ No __X__**

Please see Section III.J.1 above.

3. **Might the project impair visual access to waterfront or other scenic areas? Yes ____ No __X__**

The proposed development will not impair visual access to any waterfront or scenic amenities.

K. **Wind and Shadow**

1. **Might the project cause wind and shadow impacts on adjacent properties? Yes __X__ No ____**

Wind tunnel studies were performed by the Wright Brothers Wind Tunnel Laboratory at the Massachusetts Institute of Technology.[11] Results of the studies suggest the proposed complex will reduce pedestrian-level winds both at the site and in the surrounding blocks. Reduction of high winds was particularly noticeable around the John Hancock Tower and Trinity Church in the model tested.

Initial shadow studies have been completed and indicate that impacts on Boylston and Newbury Streets are minimal and appear acceptable. Subsequent studies have indicated that the "tot lot," on the corner of Commonwealth Avenue and Clarendon Street, may have some additional shadow cast on it for about 45 minutes prior to 11:00 am during a 30-day period primarily in December. Further studies of wind and shadow impacts will be conducted prior to design completion.

11 "A Wind Tunnel Study of Pedestrian Level Winds at the Proposed New England Life Building." Tito A. Rodriguez and Frank E. Durgin, Wright Brothers Facility, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, MA, May 1983.

IV. CONSISTENCY WITH PRESENT PLANNING

A. Describe any known conflicts or inconsistencies with current federal, state and local land use, transportation, open space, recreation and environmental plans and policies. Consult with local or regional planning authorities where appropriate.

The Joint Venture planned the project's use program and overall design in response to a BRA advertisement for developers of the St. James Garage site. There has been ongoing public participation in the formulation of the Joint Venture's design program. As part of the proposal's review process, the Civic Advisory Committee (CAC) was created by the BRA to represent the interests/concerns of the Back Bay and adjoining South End community. It includes representatives from the Back Bay Architectural Commission, Back Bay Association, Back Bay Federation, Boston Society of Architects, Ellis Neighborhood Association, Neighborhood Association of the Back Bay, Newbury Street League, Trinity Church, and the State Representative from the 8th Suffolk District.

The BRA determined that the Joint Venture's proposal met their initial guideline (BRA Memorandum, December 8, 1983). As stated by the BRA, "their proposal will greatly benefit the City, and is consistent with the overall development guidelines." The CAC, following direct review and consultation with the proponents, has provided their unanimous approval subject to the "Resolution of the St. James CAC of December 6, 1983." The Boston Society of Architects also commented on the project, indicating that the "removal of the Boylston Street block, in its entirety, for development is desirable." Furthermore, the project is consistent with the Back Bay Federation's Development Goals which state that "Copley Square should be refocused to act as the 'center' of Back Bay."

This development will also be subject to the City of Boston's policy on linkage between downtown development and neighborhood housing. The Joint Venture's project will assist in the city's effort to create low to moderate-income housing within city neighborhoods.

V. FINDINGS AND CERTIFICATION

A. The notice of intent to file this form has been/will be published in the following newspaper(s):

(Name)	(Date)
The Boston Globe	May 31, 1984
The Boston Herald	May 31, 1984

B. This form has been circulated to all agencies and persons as required by Appendix B.

May 31, 1984
Date

Kenneth S. Moczulski
Signature of Responsible Officer or Project Proponent

Name (print or type)

Address

Telephone Number

Kenneth S. Moczulski
Gerald D. Hines Interests
535 Boylston Street
Boston, MA 02116
(617) 548-4900

May 31, 1984
Date

Signature of person preparing ENF (if different from above)

Karen B Alschuler
Name (print or type)

Address

Telephone Number

Karen B. Alschuler
Skidmore, Owings & Merrill
334 Boylston Street
Boston, MA 02116
(617) 247-1070

ATTACHMENT 1

ST. JAMES AVENUE

CIVIC ADVISORY COMMITTEE

MEMBERSHIP LIST

CAC MEMBER	CONTACT PERSON(S)
Back Bay Architectural Commission	David R. Johnson Johnson Olney Associates, Inc. 75 Kneeland Street Boston, MA 02111 482-2806
Back Bay Association	Kevin A. Cartwright 655 Boylston Street Boston, MA 02116 266-1991
Back Bay Federation	No Representative At This Time
Boston Society of Architects	Tony Tappe A. Anthony Tappe & Associates, Inc. 132 Lincoln Street Boston, MA 02111 451-0200
Neighborhood Association of the Back Bay (NABB)	Fritz Casselman Bromberg, Sunstein & McGregor 31 Milk Street Boston, MA 02109 426-6464 Elliott Laffer 90 Commonwealth Avenue Boston, MA 02116 890-7220
Newbury Street League	Jon Rotenberg 561 Boylston Street Boston, MA 02116 536-2090
The State Representative from the 8th District	Thomas J. Vallely House of Representatives State House, Room 540 Boston, MA 02133 722-2090

CAC MEMBER	CONTACT PERSON(S)
Trinity Church	Rev. Spencer M. Rice Trinity Church Copley Square Boston, MA 02116 536-0944
	Jack Hall 14 Story Street Cambridge, MA 02138 576-7615
Ellis Street Neighborhood Association	Ken Gritter 52 Chandler Street Boston, MA 02116 876-4300

3365A:25-27

ATTACHMENT 2

500 BOYLSTON STREET PROJECT: SCOPE OF ENVIRONMENTAL STUDIES

TO BE UNDERTAKEN BY THE DEVELOPER

FOR THE BOSTON REDEVELOPMENT AUTHORITY

500 Boylston Street Project: Scope of Environmental Studies
(To be undertaken by the developer for the Boston Redevelopment Authority.)

The environmental studies will examine the impacts of the project proposed by New England Mutual Life Insurance Company and Gerald D. Hines Interests, Inc., as compared to the impacts of the no-build alternative which assumes continuation of the existing uses. In all cases where adverse impacts are anticipated or determined, mitigation measures to minimize, reduce or avoid these adverse impacts should be identified.

1. Pedestrian-Level Wind Impact (Also See Detailed Attachment)

   a. Wind tunnel testing should use a "hot wire" method of study of pedestrian and public areas (entrances, plazas) and of potential problem areas adjacent to and in the vicinity of the project site (wind influence area). Potential air flow modifications due to project elements should also be noted.

   b. Identification and testing of mitigation measures.

2. Shadow Impact

   a. This study should examine shadow impacts for 10 a.m., 12 noon, and 3 p.m. Seasonal periods of interest include:

Summer solstice	22 June
Winter solstice	22 December
Spring/Fall equinoxes	21 March or 22 September.

   The study should distinguish both additional and overlapping shadows caused by the project.

3. Transportation Impacts

   a. General

      o Project traffic generation (daily and peak-hour) in the project impact area. (See attached Study Area Plan.)
      o Modal split.
      o Regional distribution.

   b. Vehicular Traffic

   Traffic impacts should be analyzed for the site and the National Garage impact areas. This should include:

- o Circulation and access impacts on local/regional street system and local intersections.
- o Peak-hour travel demand (a.m. and p.m.).
- o Level-of-service analysis.
- o Truck service/deliveries to the project site, with particular regard to proposed loading dock configuration.

c. Parking

Parking studies of the project and National Garage should also be conducted and should entail the consideration of:

- o Parking requirements.
- o Effect on parking supply/demand distribution in area.
- o Public/private as well as short-term and commuter use of parking spaces.
- o Parking management plan.

d. Pedestrian Circulation

- o Demand/capacity analysis (pedestrian densities).
- o Connections to public transit stations/stops/terminals.
- o Effect on pedestrian flow of project's entrances and exits for parking.

e. Public Transportation

- o Usage and capacity (rapid transit, bus, commuter rail).
- o Peak-hour demand/capacity.

f. Construction Period Impacts

- o Parking requirements (workers, equipment, trucks).
- o Truck access routes.

4. <u>Air Quality Impacts</u>

a. Impact on local air quality from additional traffic generated by the project.

b. Emissions from parking garage.

c. Construction-related impacts (demolition, site preparation, construction activities, construction traffic and equipment).

5. Historic/Archaeological Impacts

   a. Potential impacts on adjacent and nearby historic properties (Back Bay Architectural District, Bonwit Teller, Trinity Church) in terms of compatibility, scale, materials, and views and vistas.

   b. Examination of the historic/contextual significance of the Colton Building, 462 Boylston Street.

   c. Consideration of archaeological importance of site and, if significant, identification of measures for proceeding in conjunction with appropriate public officials.

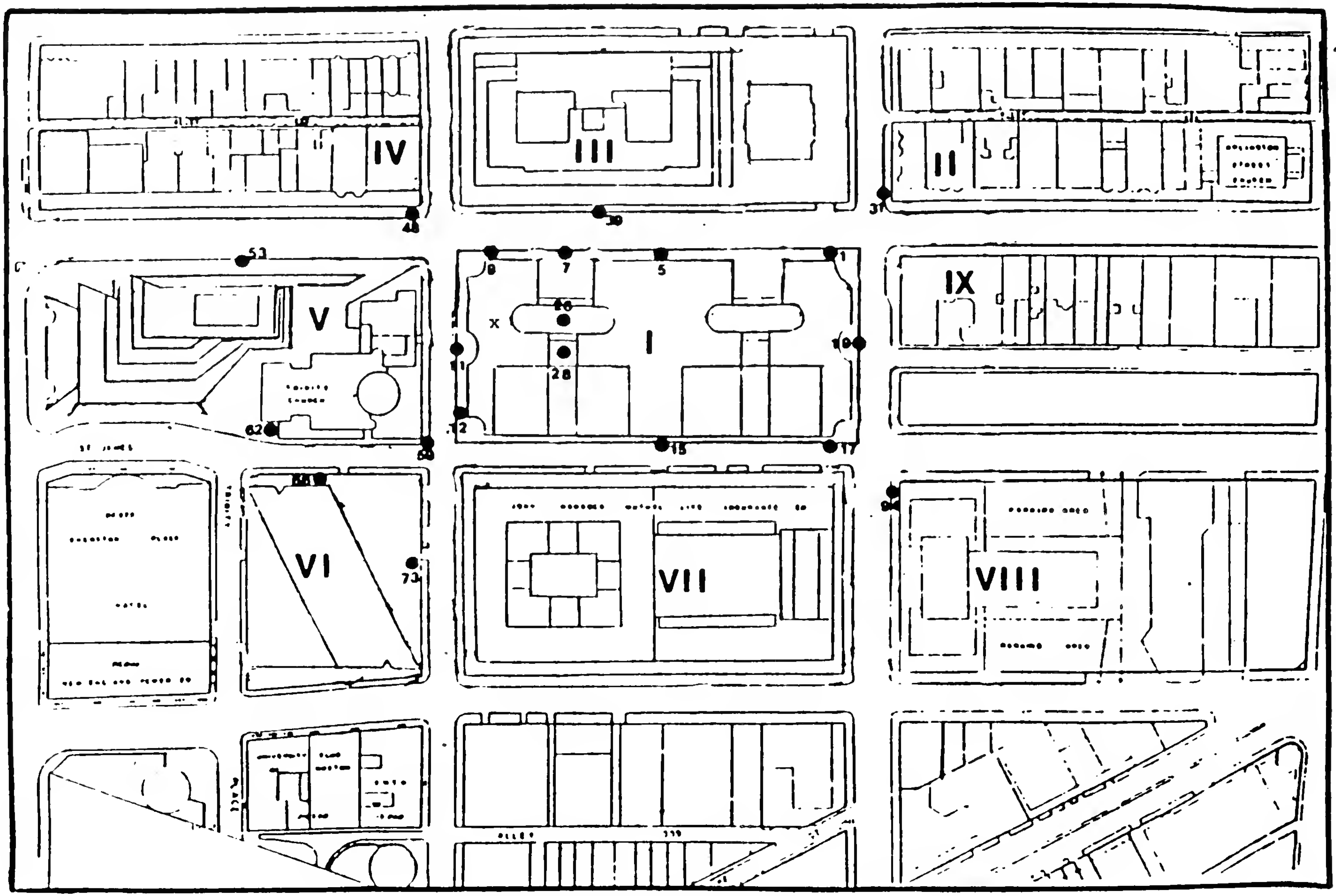
6. Natural Resources Impact

   a. Potential effects on, or changes in, groundwater levels, and impacts on existing wooden piles of surrounding buildings.

   b. Potential effects of ground (sub-soil) conditions, including potential for ground movement and settlement during excavation and resultant impact on surrounding buildings and St. James Avenue sewers. This should include impacts on the sewer's capacity to handle demand.

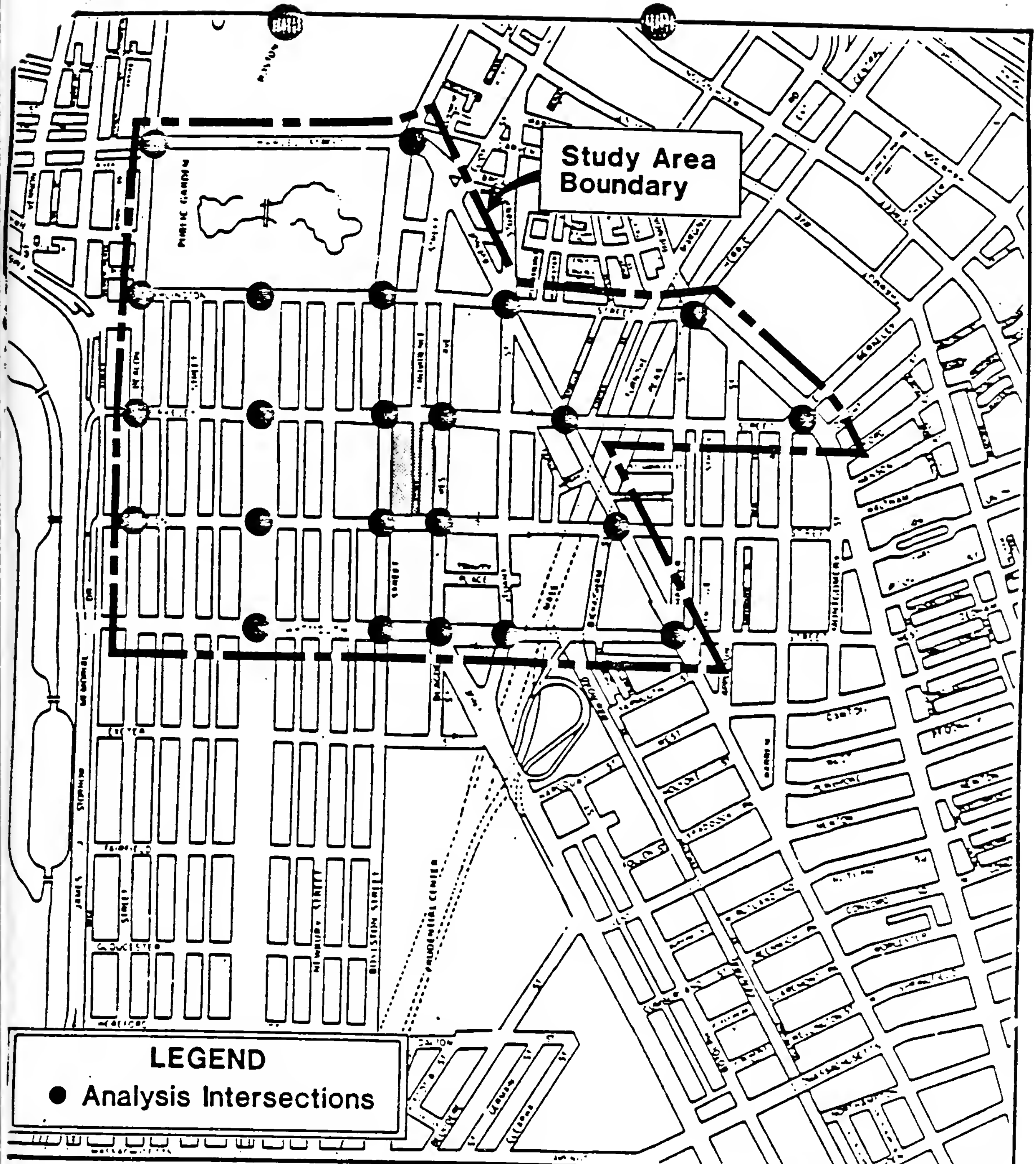
   c. Examination of what can be done to reduce the noise impact of piling if the same are used for the building foundation.

3365A:28-31



MAP OF TEST AREA AND LOCATION
OF HOT WIRE TESTING POINTS - 17 Current
21 With Project

x New sensor point



St. James Development
Traffic Impact and Access Study

Study Area Plan

Vanasse/Hangen Associates
Boston, MA

Fig 1

ATTACHMENT

PEDESTRIAN-LEVEL WIND IMPACT STUDY

1. Present data for existing and future build scenario as follows:

   Mean velocity (exceeded 1% of the time)
   Effective gust velocity (exceeded 1% of the time).

2. Compare mean and effective gust wind speeds on both annual and seasonal basis.

3. Provide a written descriptive analysis of wind environment and impacts for each sensor point, including such items as wind direction, seasonal variations, etc., as applicable. Include analysis of suitability of location for varipus activities (e.g., walking, sitting, eating, etc.) as appropriate.

4. Provide maps of sensor locations with wind speed data.

5. Provide graphical description of wind environment related to suitability for various activities.

6. If necessary, develop design modifications to mitigate impacts in areas where winds exceed acceptable levels. Maximum acceptable levels for the build scenario shall be defined as effective gust speeds of 31 mph no greater than 1% of the time. Gust speeds for the build scenario in excess of 31 mph will be acceptable if they are in fact the same as or lower than existing condition.

7. If necessary, test modified design, providing data as outlined under Items 1-6 above.

3277A:44

LETTER OF JUNE 5, 1984, AMENDING ENF

Gerald D. Hines Interests 535 Boylston Street, 11th Floor Boston, Massachusetts 02116 Area Code 617, 578-4946

June 5, 1984

Secretary James S. Hoyte
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, MA 02202

Dear Secretary Hoyte:

Reference is made to the Environmental Notification Form ("ENF") for 500 Boylston Street submitted on May 31, 1984.

Subsequent to our filing of the ENF, the plans for the emergency generator for the project were finalized. The emergency generator will have a capacity in excess of 3,000,000 B.t.u. per hour. Consequently, a fossil fuel utilization permit will be required pursuant to 310 C.M.R. 7.04. We would appreciate your considering this additional information in your review of the ENF.

I enclose substitute pages 2, 3, and 8 of the ENF which include the revisions necessitated by this additional information. Please acknowledge receipt of these items in the space provided on the enclosed copy of this letter and return to me in the enclosed envelope.

Please contact me if you should have any questions.

Sincerely yours,

Kenneth S. Moczulski

Kenneth S. Moczulski

KSM/kc

Enclosures

cc Ms. Karen Alschuler, S.O.M.
Mr. Joseph W. O'Connor, New England Life
Mr. Robert Ryan, Boston Redevelopment Authority
Mr. Mitchell Fischman, Boston Redevelopment Authority
Attorney Elizabeth C. Ross, Hale and Dorr

Receipt Acknowledged: By:______________________

Date:____________________

The 1.2 million square feet of office space will be primarily located in two towers, rising 19 stories above a 6-story base (maximum project height is 25 stories). The towers are situated to the rear of the site along the St. James Avenue boundary. Portions of the office use are also located in the upper floors of this 6-story base structure. Approximately 100,000 square feet of retail/commercial use will be contained in the first two levels of the 6-story structure. Approximately 1,000 on-site parking spaces will be provided below grade, of which 625 spaces will be designated for public use. Service and parking entrance and exit to the site will be from St. James Avenue, Berkeley Street, and Clarendon Street. Pedestrian open areas will include the sidewalk and two open plazas on Boylston Street. These plazas will be lined with active retail uses and will provide an open plaza entry to portions of the office structure.

The Joint Venture has already initiated a number of environmental studies as part of the public review process established with the CAC. To date, this work has included wind tunnel, transportation and parking, and geotechnical studies in order to identify potential project impacts.

The project is categorically included under Class D(a) of Appendix C of the MEPA Regulations. The only State permits required for the project are sewer permits from the DWPC and MDC and a fossil fuel utilization permit from DEQE for the emergency generator. In accordance with the MEPA statute, M.G.L. c. 30, Sections 61-62H, which provides at Section 62A that the scope of an EIR is "limited to that part of the project which is within the subject matter jurisdiction of the [State] permit," the scope of the EIR for the project will be limited to a discussion of sewerage and air quality impacts. The proponent has agreed to prepare a broadly scoped environmental impact review discussing the impacts of the project on wind, shadow, transportation, air quality, and historical, archaeological and geotechnical/ sewerage resources which will be subjected to critical review by the BRA and the CAC, which represents major Back Bay and South End neighborhood and business groups. A summary of the studies to be conducted in connection with the proposed environmental impact review is attached hereto as Attachment 2. The proponent requests a waiver of the requirement of filing an EIR for the project on the basis that the studies to be conducted by the proponent for the BRA and the CAC will serve to minimize damage to the environment from the project to a greater extent than could be achieved by any agency after preparation of an EIR on sewerage and air quality impacts.

This project is one which is categorically included and therefore automatically requires preparation of an Environmental Impact Report: YES ___X___ NO ________

D. Scoping (Complete Sections II and III first, before completing this section.)

1. Check those areas which would be important to examine in the event that an EIR is required for this project. This information is important so that significant areas of concern can be identified as early as possible, in order to expedite analysis and review.

	Construction Impacts	Long Term Impacts		Construction Impacts	Long Term Impacts
Open Space & Recreation			Mineral Resources		
Historical		X	Energy Use		X
Archaeological		X	Water Supply & Use		X
Fisheries & Wildlife			Water Pollution		
Vegetation, Trees			Air Pollution	X	X
Other Biological Systems			Noise	X	X
Inland Wetlands			Traffic		X
Coastal Wetlands or Beaches			Solid Waste	X	X
Flood Hazard Areas			Aesthetics		X
Chemicals, Hazardous Substances, High Risk Operations	X		Wind and Shadow		X
Geologically Unstable Areas	X		Growth Impacts		X
Agricultural Land			Community/Housing and the Built Environment		X
Other (Specify)					

2. List the alternatives which you would consider to be feasible in the event an EIR is required.

A "No Build" alternative, continuing the existing use, will be included as a base for comparing project impacts.

E. Has this project been filed with EOEA before? Yes ______ No X
If Yes, EOEA No. ______ EOEA Action? ______

F. Does this project fall under the jurisdiction of NEPA? Yes ______ No X
If Yes, which Federal Agency? ______ NEPA Status? ______

G. List the State or Federal agencies from which permits will be sought:

Agency Name	Type of Permit
Mass. Department of Environmental Quality Engineering	Sewer Extension Permit (Ch. 21, S.43); Fossil Fuel Utilization Permit (MGL Ch. 111, S.142 A-E; 310 CMR 7.04 for emergency generator)
Mass. Historical Commission	Determination of Effect to Historic Properties.[1]
Metropolitan District Commission	Industrial User Discharge Permit (MGL Ch.92, S1-8A).

[1]Although this determination will be required for the project, it is the view of the proponent and EOEA that such determination does not constitute a state permit under MEPA.

H. Will an Order of Conditions be required under the provisions of the Wetlands Protection Act (Chap. 131, Section 40)?
Yes ______ No X
DEQE File No., if applicable: ______

I. List the agencies from which the proponent will seek financial assistance for this project:

Agency Name	Funding Amount
None.	

II. PROJECT DESCRIPTION

A. Include an original 8½ x 11 inch or larger section of the most recent U.S.G.S. 1:24,000 scale topographic map with the project area location and boundaries clearly shown. Include multiple maps if necessary for large projects. Include other maps, diagrams or aerial photos if the project cannot be clearly shown at U.S.G.S. scale. If available, attach a plan sketch of the proposed project. (Attached)

B. State total area of project: 137,074 square feet (± 3.15 acres)
Estimate the number of acres (to the nearest 1/10 acre) directly affected that are currently:

1. Developed .... 3.15 acres
2. Open Space/Woodlands/Recreation ____ acres
3. Wetlands .... ____ acres
4. Floodplain .... ____ acres
5. Coastal Area .... ____ acres
6. Productive Resources
   - Agriculture .... ____ acres
   - Forestry .... ____ acres
   - Mineral Products .... ____ acres

C. Provide the following dimensions, if applicable:
Length in miles ______ Number of Housing Units ______ Number of Stories 6 to 25

	Existing[2]	Immediate Increase Due to Project[2]
Number of Parking Spaces[3] (on-site)	625	375
Vehicle Trips to Project Site (average daily traffic)	1,700	3,340[4]
Estimated Vehicle Trips past project site		
Clarendon Street	10,000	1,000
Boylston Street	18,900	500
Berkeley Street	19,400	600
St. James Avenue	11,900	1,800

For footnotes 2, 3, and 4 see following page.

D. If the proposed project will require any permit for access to local or state highways, please attach a sketch showing the location of the proposed driveway(s) in relation to the highway and to the general development plan; identifying all local and state highways abutting the development site; and indicating the number of lanes, pavement width, median strips and adjacent driveways on each abutting highway; and indicating the distance to the nearest intersection. (Not applicable)

G. Air Quality

1. Might the project affect the air quality in the project area or the immediately adjacent area?
Yes X No ____

Describe type and source of any pollution emission from the project site.

Some air pollution will be generated by the project. Increased numbers of vehicles visiting the site and using the underground parking garage will contribute to air pollution in the area. Emission vents for the garage will be located to minimize any adverse environmental impacts related to pedestrian areas or air intakes for nearby buildings. Short-term air quality impacts from fugitive dust will occur during construction. In addition, there is the possibility that asbestos exists in some of the buildings slated for demolition. If further research indicates asbestos, a removal plan will be formulated and there will be compliance with all applicable DEQE regulations.

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any pollution emissions caused by the project, including construction dust? Yes X No ____

Explanation and Source:

Sensitive receptors in the area include public and pedestrian spaces at nearby intersections, such as Copley Square, and adjacent building air intakes.

3. Will access to the project area be primarily by automobile? Yes ____ No X
Describe any special provisions now planned for pedestrian access, carpooling, buses and other mass transit.

According to Vanasse/Bangen's recent study of the proposed project's transportation impacts,[9] the majority (60 percent) of new person-trips to the site will be by transit or by walking. The remaining 40 percent of the daily trips will be by personal car, carpool/vanpool, or taxi.

Public transit service to the area currently consists of express buses, commuter rail to the Back Bay Station, and light rail rapid transit (the Green Line). The relocation of the Orange Line to the Back Bay Station will make this station a major regional transportation hub. Furthermore, the expanded capacities of the Orange and Green Lines in the future are expected to result in a transit capacity surplus for the Back Bay, fostering mode shifts to transit from private vehicles. In addition, New England Life will continue to operate its vanpool program.

---

9 Transportation Impact Study, Proposed St. James Development, Boston, Massachusetts.' Prepared for New England Life/Gerald D. Bines Interests. Vanasse/Bangen Associates, Inc., Boston, MA, June 1983.

H. Noise

1. Might the project result in the generation of noise? Yes X No ____

Noise will be generated during the demolition/construction phase, over the short-term. All demolition/construction practices will be in compliance with 310 CMR 7.10, to minimize adverse noise impacts. Long-term noise effects will result from increased vehicular activity at the site after its completion.

2. Are there any sensitive receptors (e.g., hospitals, schools, residential areas) which would be affected by any noise caused by the project? Yes X No ____

Explanation and Source:

Sensitive receptors in the area include Trinity Church, pedestrian walkways, public open areas, such as Copley Square, and adjacent buildings.

Appendix 2

Transportation

The following traffic count summary and analysis sheets are for existing conditions at the Clarendon/Tremont unsignalized intersection. See Comment 32 under the Transportation subsection of Chapter IV of this Final BRA EIR.

CONSULTING ENGINEERS ARCHITECTS
AND PLANNERS

City Boston - Roxbury
Intersection Clarendon St. & Tremont St

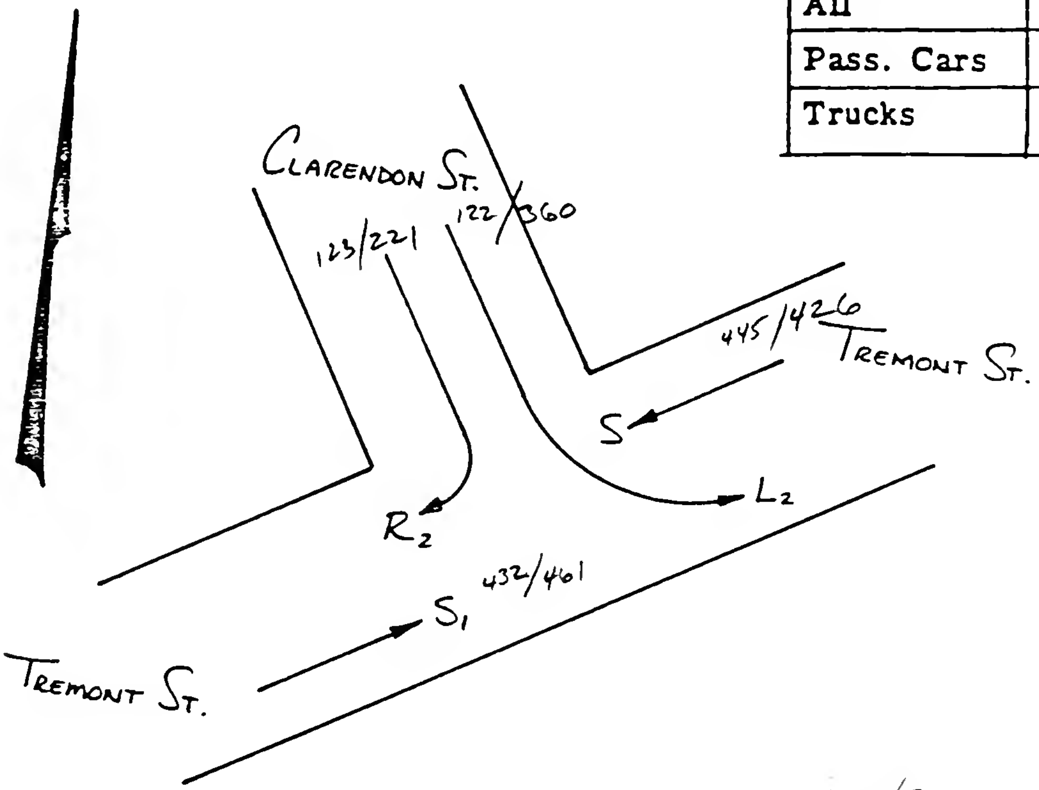
INT. NO. 120

Date 6/22/83 Day of Week Weds

INTERSECTION TURNING MOVEMENT COUNT

1250

Vehicles Counted	
All	X
Pass. Cars	
Trucks	



AM/PM peak hours

Weather
Clear & Dry
Count Taken By
John Zampine III

Length of Count	
Time	Number of Hours
7am-6pm	11 hrs

Street	Entering Volume	Flow Percent	Comments
Tremont St. (WB)	3766	37%	
Tremont St. (EB)	3687	36%	
Clarendon St. (SB)	2795	27%	
Total	10,248	100%	

TRAFFIC STREAM GAP ANALYSIS PACKAGE

VER 3.5.4 SEPT84

BY: MFK
DATE: 12/18/84
JOB #: 0875

BOSTON, MASS
TREMONT STREET/CLARENDON STREET
EXISTING AM - LEFT OUT

DATA

FIRST VEHICLE CRITICAL GAP, T1, ... 5 SECONDS
ADDITIONAL TIME NEEDED FOR SECOND VEHICLE, B1, ... 3 SECONDS
MOVE UP TIME, B2, ... 2.5 SECONDS

OPPOSING TRAFFIC
    VOLUME.. 683 VPH
    ARRIVAL RATE.................................. .19 VPS
ANALYSIS MOVEMENT TRAFFIC
    VOLUME.. 122 VPH
    ARRIVAL RATE.................................. .034 VPS

RESULTS

CAPACITY= 609 VPH

RESERVE CAPACITY= 487 VPH

ACCEPTABLE GAPS
    PERCENT OF ALL GAPS........................... 38.7 PERCENT
    AVERAGE LENGTH................................ 10.[illegible] SECONDS

AVERAGE DELAY TO A VEHICLE AT STOP BAR
    TO ALL VEHICLES............................... .[illegible] SECONDS
    TO DELAYED VEHICLES ONLY...................... [illegible].6 SECONDS

AVERAGE WAIT IN A QUEUE
    TO ALL VEHICLES............................... 1.5 SECONDS
    TO QUEUED VEHICLES ONLY....................... 7.[illegible] SECONDS

AVERAGE DELAY PLUS AVERAGE WAIT
    TO ALL VEHICLES............................... 1.8 SECONDS
    TO DELAYED AND QUEUED VEHICLES ONLY........... 11 SECONDS

QUEUE LENGTH
    AVERAGE....................................... [illegible] VEHICLES
    95TH PERCENTILE............................... 1[illegible] VEHICLES

LEVEL OF SERVICE --- A ---

TRAFFIC STREAM GAP ANALYSIS PACKAGE

VER 3.5.4 SEPT84

BY: MFK
DATE: 12/18/84
JOB #: 0875

BOSTON, MASS
TREMONT STREET/CLARENDON STREET
EXISTING PM - LEFT OUT

DATA

FIRST VEHICLE CRITICAL GAP, T1, ... 5 SECONDS
ADDITIONAL TIME NEEDED FOR SECOND VEHICLE, B1, ... 3 SECONDS
MOVE UP TIME, B2, ... 2.5 SECONDS

OPPOSING TRAFFIC
VOLUME..................................... 680 VPH
ARRIVAL RATE............................... .189 VPS
ANALYSIS MOVEMENT TRAFFIC
VOLUME..................................... 360 VPH
ARRIVAL RATE............................... .1 VPS

RESULTS

CAPACITY= 611 VPH

RESERVE CAPACITY= 251 VPH

ACCEPTABLE GAPS
PERCENT OF ALL GAPS......................... 36.9 PERCENT
AVERAGE LENGTH.............................. 10.3 SECONDS

AVERAGE DELAY TO A VEHICLE AT STOP BAR
TO ALL VEHICLES............................. .3 SECONDS
TO DELAYED VEHICLES ONLY.................... 3.6 SECONDS

AVERAGE WAIT IN A QUEUE
TO ALL VEHICLES............................. 8.4 SECONDS
TO QUEUED VEHICLES ONLY...................... 14.3 SECONDS

AVERAGE DELAY PLUS AVERAGE WAIT
TO ALL VEHICLES............................. 8.8 SECONDS
TO DELAYED AND QUEUED VEHICLES ONLY......... 18 SECONDS

QUEUE LENGTH
AVERAGE..................................... 1.4 VEHICLES
95TH PERCENTILE............................. 4 VEHICLES

LEVEL OF SERVICE --- C ---

Appendix 3
Wind

500 Boylston Street Project

BRA Final Environmental Impact Report

February 1985

Submitted to	Boston Redevelopment Authority
Project Proponent	A Joint Venture of New England Mutual Life Insurance Company Gerald D. Hines Interests, Inc.
Prepared by	Skidmore, Owings & Merrill Vanasse/Hangen Associates, Inc. Haley & Aldrich, Inc. Tech Environmental Wright Brothers Facility, MIT Historic Preservation Planning & Analysis

A WIND TUNNEL STUDY OF PEDESTRIAN LEVEL WINDS FOR THE PROPOSED NEW ENGLAND LIFE COMPLEX IN BOSTON

PHASE THREE

DECEMBER 1984 WBWT TR 1222

BY

FRANK H. DURGIN

JOHN J. BUSCH

SUBMITTED TO
GERALD D. HINES INTERESTS
426 BOYLSTON STREET
BOSTON, MASSACHUSETTS, 02116

ATTENTION MR. KENNETH S. MOCZULSKI

FROM
THE WRIGHT BROTHERS FACILITY
DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASSACHUSETTS, 02139.

TABLE OF CONTENTS

1.	INTRODUCTION	1
2.	TEST CONFIGURATIONS	
	2.1 Sixty Foot Spacing	3
	2.2 Tree Configuration I	3
	2.3 Tree Configuration II	3
	2.4 Tree Configuration III	4
3.	THE EXPERIMENTAL EQUIPMENT	5
4.	DESCRIPTION OF THE HOT WIRE TECHNIQUE	6
5.	CRITERIA	
	5.1 BRA Guideline Effective Gust Velocity	7
	5.2 Melbourne's Criteria	7
6.	REDUCTION OF DATA	9
7.	RESULTS	
	7.1 Introduction	10
	7.2 Effects of Changing Spacing of the Towers	10
	7.3 Effect of Tree Additions	
	7.3.1 Tree Configuration I	11
	7.3.2 Tree Configuration II	11
	7.3.3 Tree Configuration III	12
	7.4 Seasonal Effects	12
8.	CONCLUSIONS	14
REFERENCES		15
APPENDIX I	DESCRIPTION OF THE EXPERIMENTAL EQUIPMENT	47
APPENDIX II	CALIBRATION OF THE SIMULATED EARTH'S BOUNDARY LAYER	48
APPENDIX III	REDUCTION OF DATA	53
APPENDIX IV	CRITERIA FOR PEDESTRIAN LEVEL WINDS	57
List of Figures		ii
List of Tables		iii

LIST OF FIGURES

Fig.		
1	Schematic Diagram of Wright Brothers Facility	17
2	Schematic Diagram of Boundary Layer Simulation	18
3	Ground Wind Hot Wire Setup and Angle Calibration	19
4	Types of Earth's Boundary Layer after Davenport	20
5	Pedestrian Level Wind Criteria Graph	21
6	Legend for Pedestrian Level Wind Criteria Graph	22
7	Melbourne's Criteria for Average Winds	23
8	Melbourne's Criteria for Effective Gusts	24
9	Melbourne's Criteria for Peak Gusts	25
10	Change in building design from Feb. 1983 to May 1984	26
11	Map of New England Life Area with the Locations of Stations Used in the Tests	27
12	Location of Trees for Tree Configuration I	28
13	Location of Trees for Tree Configuration II	29
14	Location of Trees for Tree Configuration III	29
15	Model City in the Wind Tunnel	31
16	Towers of the NEL Complex Separated by 60 ft.	31
17	Tree Configuration I	33
18	Tree Configuration II	33
19	Tree Configuration III	35
20	Tree Configuration III with Hot Wire Ready for Testing at Station 59	35
Boston Wind Rose		
21	for Year	37
22	for Winter (Dec.,Jan.,Feb.)	38
23	for Spring (March,April,May)	39
24	for Summer (June,July,Aug.)	40
25	for Fall (Sept.,Oct.,Nov.)	41
- - - - -		
A1	Variation of average velocity with height	60
A2	Normalized turbulence intensity as a function of height-tunnel center line	61
A3	Comparison of wind tunnel data to boundary layer power spectrum theories	62

LIST OF TABLES

Table		
1	Beaufort Wind Scale for Pedestrians after Penwarden	42
2	Comparison Between Different Configurations for the 1% Predicted Average, Effective Gust and Peak Gust Velocities	43
3	Melbourne's Category for Each Station - Annual and Seasonal	46
A1	Weibull Constants for Boston Annual, Winter, Spring, Summer, Fall	63-67
A2	Ground Wind Hot Wire Study for NEL Project, Phase III	
.1	60 Foot Separation	68-72
.2	Tree Configuration I	73-77
.3	Tree Configuration II	78-82
.4	Tree Configuration III	83-87
A3	Ground Wind Hot Wire Study for NEL Project - Phase III	
.1	Twin Towers Separated by 60 feet - No Trees	88-119
.2	Tree Configuration I - Towers Separated by 60 feet	120-127
.3	Tree Configuration 2 - Towers Separated by 60 feet	128-137
.4	Tree Configuration 3 - Towers Separated by 60 feet	138-143
A4	Ground Wind Hot Wire Study for NEL Project - Phase III	
.1	Twin Towers Separated by 60 feet - No Trees	144-146
.2	Tree Configuration 1 - Towers Separated by 60 feet	147-149
.3	Tree Configuration 2 - Towers Separated by 60 feet	150-152
.4	Tree Configuration 3 - Towers Separated by 60 feet	153-155

A WIND TUNNEL STUDY OF PEDESTRIAN LEVEL WINDS FOR THE PROPOSED NEW ENGLAND LIFE COMPLEX IN BOSTON PHASE THREE

By: Frank H. Durgin
John J. Busch

1. INTRODUCTION

The proposed New England Life (NEL) complex at 500 Boylston Street will occupy the entire block bordered by Boylston Street, Clarendon Street, St. James Avenue, and Berkeley Street. The towers in the complex will be 329 feet tall which is about 50 feet lower than the original 26 story John Hancock building located on the opposite side of St. James Avenue. The John Hancock tower (800 ft. high) is located on the block just to the southwest. The area around the John Hancock tower is noted for having strong winds as well as complex wind patterns. Because of the proximity of the John Hancock tower as well as the height of the proposed NEL building, a pedestrian level wind study of the area was undertaken at the Wright Brothers Facility (WBF) to determine the influence of the NEL complex on winds near its base and in the surrounding area. This study has been carried out in three phases, the latest of which is described in detail in this report.

The first phase [22] was completed in May, 1983 and used an erosion technique to investigate pedestrian level winds over a large area around this complex. A thin layer of rice sized plastic particles was placed over all areas to be investigated. The wind speed was increased in 5 mph increments and the areas where the particles were eroded for each wind speed were noted. One test was run with a simulation of existing conditions and a second test was run with a model of the proposed NEL complex in place. The results of this study showed that replacing the existing buildings with the proposed complex would have the net effect of reducing pedestrian level winds both near the complex as well as within a radius of a block or two.

The second phase [7] used a hot wire technique to measure the pedestrian level winds and was completed in August, 1984. The hot wire technique is relatively quantitative in comparison with the erosion technique. However, wind speeds can only be determined at a limited number of predetermined points referred to as stations. Between the first and second phases the model was modified to reflect the fact that the towers had been reduced from 396 to 329 feet tall and that the six story base was modified slightly (see Figure 10). Thirty-two stations were chosen for this test. These stations included those observed to be most windy from the erosion test as well as other stations of

interest in and around the complex. As in the first phase, two tests were performed, one with the existing buildings and one with the proposed NEL complex. The results showed that the winds at stations within the complex were reduced and winds at stations outside the complex were essentially unchanged. However, there were a few stations that displayed increased velocities that were previously at a high level. No stations which had predicted pedestrian level winds under the BRA criteria for existing conditions were found to be over the BRA criteria with the proposed complex in place.

A third phase, again using the hot wire technique, was performed in December, 1984. The planned separation of the towers of the NEL complex was increased from 50 to 60 feet for this most recent model. Model buildings representing the new 399 Boylston Street building and the new Ritz-Carlton Condominiums were added to update the base model of the city. The same 32 stations considered in the second phase were tested again, and the results have been compared to the 50 foot spacing and existing conditions results.

Three tree configurations also were tested during this third phase of the testing. These configurations were chosen as mitigation measures to decrease winds in the area. Only the eight stations which were believed to be most affected by the mitigation measures were evaluated in these additional tests. In the previous wind tunnel studies no existing or planned trees were modeled. There are, however, trees near Trinity Church along Clarendon Street. Further, there are plans to place trees around the recently renovated John Hancock building on Clarendon Street (see Figure 12). Both of these sets of trees were modeled for all three tree configurations.

Some concern has been raised over station 59 100 hour return period winds were predicted to be very high for existing conditions and were further increased by the addition of the NEL complex. Trees were added to the model along St. James Avenue and Clarendon Street next to the NEL complex (Tree Configuration I) to help reduce the winds at station 59 and other nearby stations. To further diminish winds near the St. James Avenue and Clarendon Street intersection the developers of the New England Life complex have offered to plant trees along the west side of Clarendon Street near Trinity Church (see Figure 13). This configuration (II) and that of the installation of trees along St. James Avenue in the John Hancock tower plaza (III) were also tested (see Figure 14).

The remaining sections of the report will describe the various configurations and mitigation measures in detail, the experimental equipment, the tests, and the results of the tests.

2. TEST CONFIGURATIONS

2.1 SIXTY FOOT SPACING

In both Phase I and II, the towers of the NEL complex were separated by 50 feet. Between the second and third phase the proposed spacing was increased to 60 feet. This was the only change made to the NEL complex model (see Figure 16) between the two hot wire tests. Two buildings were completed in the vicinity of the proposed NEL complex after the first study. These are the 399 Boylston Street building and the Ritz-Carlton Condominiums, which were modeled and added to the base model of the city for the third phase. All 32 stations used in the second phase were included in this third phase. All other tests in the third phase used the 60 foot tower separation.

2.2 TREE CONFIGURATION I

There are one 15 foot and four 50 foot tall trees next to Trinity Church that were not modeled for any of the previous tests. Six 35 foot and six 15 foot tall trees are planned to be located on each of the north, west, and south sides of the recently renovated John Hancock building on Clarendon Street. Also, seven 35 foot tall trees along Clarendon Street and eight 35 foot tall trees along St. James Avenue have been proposed to be located next to the NEL complex. The locations of these three sets of trees is shown in Figures 12 and 17. The purpose of this test configuration was to determine whether or not the trees would improve wind conditions with particular attention paid to those stations determined to be most windy in Phase II. The trees are modeled after full grown deciduous trees with full foliage. Thus, predicted winds from this test will be underestimated prior to maturity of the trees as well as for conditions during the winter season when there will not be full foliage if deciduous trees are used. Of course, if coniferous trees are used instead the results will be valid for winter.

2.3 TREE CONFIGURATION II

The developers of the NEL complex have offered to install nine trees along Clarendon Street and three trees along St. James Avenue near Trinity Church to diminish winds near that intersection particularly at station 59. The trees are to be 35 feet tall and similar to those to be planted at the NEL complex. Their locations can be seen in Figures 13 and 18. These modeled trees were added to the first tree configuration to obtain the second tree configuration.

2.4 TREE CONFIGURATION III

Twenty 15-20 foot tall trees have been proposed to be positioned at the John Hancock plaza along St. James Avenue. The decision as to whether or not the trees will be installed does not rest with the developers of the NEL complex but rather with the John Hancock Mutual Life Insurance Company and the City of Boston. The trees were added to the second tree configuration for this third test. Their location can be seen in Figures 14, 19, and 20. There were time constraints with this test; therefore only the three wind directions that contributed the most to the expected 100 hour return period velocity at station 59 were tested. Data for the remaining 13 directions were taken from Tree Configuration II. The three major wind angles (NNE, NE, and ENE) comprise roughly 40% of the probability of the winds occurring at station 66 and roughly 70% for station 59. This implies that there is some error in the data for Tree Configuration III, but if anything the winds are overestimated since trees tend to decrease wind speeds, and the added data was for fewer trees.

3. THE EXPERIMENTAL EQUIPMENT

All testing was carried out in the Wright Brothers Memorial Wind Tunnel (see Figure 1) in a scaled simulated earth's boundary layer using a setup similar to that shown in Figure 2. The model of the city and New England Life complex that was used was constructed at a scale of 1/600 and is the same as in the two previous phases. Figure 11 is a map of the area and shows the stations at which data was taken for the various configurations. The wind tunnel and other equipment that were used are described in more detail in Appendix I. The calibration of the simulated earth's boundary layer wind is given in Appendix II. Those results show that the boundary layer wind for the test was essentially identical with that used in Phases I and II (see Figures A1, A2, and A3). The boundary layer is characterized by having a power law exponent of 0.225 and a height of 36 inches in the wind tunnel (1800 feet full scale).

4. DESCRIPTION OF THE HOT WIRE TECHNIQUE

For these hot wire tests, two hot wires were used; that is, the stations were monitored in pairs until all stations were read. The hot wires enable one to monitor the wind velocity as it varies with time at a scaled average height of about 6 feet full scale. The outputs from the two wires were filtered so that they only sensed wind gusts which were the equivalent of two seconds or longer duration full scale. Murakami et al [17] and others [13] have shown that gusts of shorter duration do not affect people. Figure 20 is a photograph of one of the hot wires at station 59 for Tree Configuration III. Figure 3 is a schematic drawing of the hot wire probe and also shows its sensivity to direction.

Each hot wire was monitored for the equivalent of one hour full scale (8.8 seconds, see Appendix I) and the average (av), the rms, and peak two second gust velocities calculated from this data. An estimated expected peak (pk) gust velocity was also calculated from the data (see Appendix III). This estimated peak velocity is a better estimate of the expected peak two second gust velocity occurring during any one hour period than the single peak reading obtained during the test [8,12]. It will be referred to here as the peak gust velocity (pk).

5. CRITERIA

5.1 THE BRA GUIDELINE EFFECTIVE GUST VELOCITY

The BRA guideline effective gust velocity is apparently based on an effective gust velocity defined by the average velocity plus 1.5 times the rms of the velocity. As described in Appendix IV this guideline velocity can also be modified to apply to the average and peak gust velocities used in this report. On that basis, the criteria for the 100 hour return period becomes:

Average velocity	22 mph
Effective gust velocity	31 mph
Peak gust velocity	43 mph

All three criteria are applicable to the hot wire data. Since the average, the rms, and the peak velocity can all or each make a station seem windy, in this report, a station is regarded to have exceeded the guideline velocity if any one of the limits is exceeded by the appropriate velocity.

5.2 MELBOURNE'S CRITERIA

In 1978 Melbourne [15] reviewed the literature to find a probabilistic criteria for hourly average pedestrian level winds that would cover different types of human activity as well as safety considerations. The results of that study are summarized in Figures 5 and 6 and described in more detail in Appendix IV. The vertical scale is the average hourly velocity in miles per hour and the horizontal scale is the probability based on hours of that average velocity occurring. Five criteria are given and labeled. They are "unacceptable and dangerous," "uncomfortable for walking," "acceptable for walking," "acceptable for short periods of standing," and "acceptable for long periods of standing or sitting." These criteria as defined for hourly average velocities have been in use at WBF for about six years.

Melbourne's criteria can also be modified to apply to both the effective gust as well as the peak gust as is described in Appendix IV. The results from using this conversion and limiting the horizontal scale to a maximum of $P(U>Up)=0.01$ (100 hours) are given in Figures 7, 8, and 9. The appropriate BRA guideline velocity is also shown in each figure (the circle with a star in it).

When Melbourne's criteria are also applied to the one hundred hour effective gust and peak gust velocities calculated in this report, his criteria can be stated as follows:

MELBOURNE'S CRITERIA FOR ONE HUNDRED HOUR OCCURRENCE AVERAGE, EFFECTIVE GUST, AND PEAK GUST VELOCITIES

		VELOCITY (MPH)		
	CATEGORY	HOURLY AVERAGE	EFFECTIVE GUST	PEAK GUST
1	UNACCEPTABLE-DANGEROUS	$27 \leq U_{av}$	$39 \leq U_{eg}$	$55 \leq U_{pk}$
2	UNCOMFORTABLE FOR WALKING	$19 \leq U_{av} < 27$	$27 \leq U_{eg} < 39$	$37 \leq U_{pk} < 55$
3	ACCEPTABLE FOR WALKING	$15 \leq U_{av} < 19$	$21 \leq U_{eg} < 27$	$30 \leq U_{pk} < 37$
4	STATIONARY SHORT EXPOSURE	$12 \leq U_{av} < 15$	$16 \leq U_{eg} < 21$	$23 \leq U_{pk} > 30$
5	STATIONARY LONG EXPOSURE	$U_{av} < 12$	$U_{eg} < 16$	$U_{pk} < 23$

The dividing line between "uncomfortable for walking" and "acceptable for walking" will be considered the equivalent of the BRA guideline velocity in Melbourne's criteria. If so, one obtains the following table for Melbourne's criteria equivalent to that given for the BRA guideline table above:

Average velocity	19mph
Effective gust velocity	27mph
Peak gust velocity	37mph

The dotted lines in Figures 5, 7, 8, and 9 show the estimated conditions at 4.5 feet at Logan Airport in Boston. Note that the dotted line lies above Melbourne's acceptable for walking criteria and slightly below the BRA guide line criteria.

In this report, only the hourly average, effective gust, and peak gust velocities that occur once in 100 hours will be used. However, each value listed really defines a complete curve like those in Figures 5, 7, 8, and 9 passing through the point $(P(U>U_p)=0.01)$.

In order to provide some perspective for the velocities in Figures 5, 7, 8, and 9 and in the tables above, Table 1 (based on the Beaufort wind scale as interpreted by Penwarden [18] for pedestrian level winds) has been included. The velocities used in Table 1 appear to be defined in a way similar to the effective gust used by the BRA as noted in the footnote in the figure. The 1% occurrence 31 mph guideline velocity used by the BRA is at the dividing line between Beaufort 6 and 7. Melbourne's equivalent dividing line velocity of 27 mph for an effective gust is in the middle of Beaufort 6. A Melbourne category has been determined for each station and can be found in Table 3.

6. REDUCTION OF DATA

All the results are presented in tables at the back of the report and in the Appendices. As noted above the average, rms, and peak gust velocities were obtained from the hot wires. These were then divided by the gradient velocity in the tunnel. The ratios of measured average, rms, or peak velocity at each station to gradient velocity in the tunnel for each configuration and wind direction are given in Table A3.1.1 - A3.4.8. Tables A3.1.1 to A3.1.32 contain the results for the 60 foot spacing of the towers in their normal position with no trees; Tables A3.2.1 to A3.2.8 contain the data for Tree Configuration I; Tables A3.3.1 to A3.3.8 for Tree Configuration II and Tables A3.4.1 to A3.4.8 for Tree Configuration III. The last column in each of these tables gives the gust factor, g (g=[Vpeak-Vave]/Vrms). The gust factor varies from about 2 to 10. Values of g less than 3 or greater than 4 imply that the distribution of the gust amplitudes is not Gaussian. Using the data in Tables A3.1.1 - A3.8.6, an effective gust (average plus 1.5 times the rms) was calculated. Based on the available literature [2, 11, 20], this is the effective gust velocity used as a measurement standared by the BRA guideline.

Next the average, the effective gust, and the peak gust velocities were used with an appropriate statistical description of the Boston wind climate (See Appendix III and the Weibull coefficients in Tables A1.1 - A1.5) to calculate the hourly average velocity, the effective gust velocity, and the peak gust velocity that will be exceeded 1% of the time at each station (i.e. once in a hundred hours or about three to four times a month during daylight hours). The results of these calculations for both annual and seasonal time periods are presented in Tables A2.1.1 to A2.4.8. The annual results are compared with the results of Phase II in Table 2.

It is also important to know which wind directions contribute the most to the 1% probability in order to be able to determine how to reduce the windiness at any station (i.e. to know which wind directions are most responsible for the windiness if corrective measures are to be taken). To that end, the percent contribution of each wind direction to the total 1% probability has been calculated for each station for each configuration for each of the three types of velocities for the annual results given in Tables A2.1.1, A2.2.1, A2.3.1, and A2.4.1. Those percent contributions are given in Tables A4.1.1 to A4.4.3. The seasonal results have not been included so as to keep the report brief, but are available from WBF. These tables are useful in determining which wind direction is most responsible for the winds at any station for each ocnfiguration. Thus, they can be used to determine what mitigation measures might be useful. Wind roses which indicate the likelihood of a particular wind direction are presented in Figures 21-25.

7. RESULTS

7.1 INTRODUCTION

The annual results from Phases II and III are presented in Table 2 for the predicted 100 hour return period average, effective peak, and peak velocities. The existing conditions and the 50 foot spacing were tested in Phase II, and the other configurations refer to Phase III. When these results are compared with the appropriate Melbourne criteria, it is relatively simple to obtain the Melbourne category for each of the three types of velocity (average, effective gust, and peak gust), but it is not easy to determine which of the three calculated velocities is the most critical, especially when all three velocity types fall into the same category. One way to overcome this problem is to divide the effective gust velocities by 1.43 and peak velocities by 2.0 to obtain "equivalent average" velocities. The highest of the three average velocities then determines the Melbourne category. Further, one can then tell which velocity is critical. This in fact, has been done, and it was found that 56% of the time the average velocity is critical and determines the Melbourne category. Further, of the 35 station conditions that fall into category 1 or 2, the critical velocity for 32 is the average velocity and the other three were determined by an "equivalent average" effective gust velocity that was less than 0.2 mph higher than the average velocity. Thus, the average 1% return period velocity is critical in nearly all cases where the estimated 100 hour return period velocities are in Melbourne category 1 or 2. Nevertheless, since the other two velocities determine the category for many stations which fall in categories 3-5, the average difference given in the last column of Table 2 also will be used for discussion purposes. The annual results for each case will be discussed first. Seasonal effects will be discussed at the end.

7.2 EFFECTS OF CHANGING THE SPACING OF THE TOWERS

Comparing the 50 and 60 foot spacing data, it is found that at some stations the 100 hour return period velocities increase while those at others decrease so that the net effect is little or no change. There does appear to be at least one trend; the velocities in the two courts facing Boylston St. are decreased (see data for stations 22, 24, 26, 28, 110, and 111). Outside of that area the balance of increased and decreased velocities is nearly even. For instance, there are four stations (11, 14, 48, and 59) where the return period velocity is changed more than 2 mph, and the stations are in Melbourne category 1 or 2 for either the 50 or 60 foot spacing. The velocities increased at stations 12 and 14 and decreased at stations 48 and 59 about equal amounts. Of the 26 stations outside of the courtyards, only 10 changed 1 mph or more, and the total change in the average

difference from those ten adds up to less than 1 mph. Comparing the predicted velocities from the same stations with those for existing conditions, those from stations 48 and 59 are now unchanged, those from 11 are significantly less and from 14 are significantly increased.

7.3 THE EFFECT OF TREE ADDITIONS

7.3.1 Tree Configuration I

The tree locations used for Tree Configuration I are shown in Figure 12. Figure 17 is a photograph of the configuration. Measurements were made at eight stations for Tree Configuration I: 11, 12, 14, 59, 62, 66, 73, and 80. All eight stations showed decreases in the predicted 100 hour return period wind speeds as compared to either the complex without trees or the existing conditions. Stations 11, 12, and 14 showed significant decreases of 8 to 14 mph when the trees were added and decreases of 4 to 15 mph compared to the model with existing conditions. The remaining stations exhibited decreased wind velocities from 1.2 to 2.5 mph from the 60 foot spacing with no trees and from 1.5 to 3.5 for existing conditions (2.3 and 2.0 mph for station 59). Stations 11, 12, and 14 fell to category 5. Other stations remained in their respective categories. Tree configuration I predicts reduced 100 hour return period velocities at two stations (11 and 14) which had increased between the 50 foot spacing and the 60 foot spacing.

7.3.2 Tree Configuration II

Tree Configuration II is shown in Figures 13 and 18. Eight stations were tested: 9, 11, 12, 14, 58, 59, 62, and 66. There is no data for station 58 for the 60 foot spacing condition, but with this tree configuration it is in category 5 which means that it is not windy at all. Station 62 remained essentially unchanged, as would be expected since it is some distance away from the trees. Table 3 indicates that this station changed from category 2 to category 1, but this is due to the fact that for both tests the wind speed fell within 0.2 mph of the category cutoff point. Interestingly, Tree Configuration I recorded a lower wind speed at this station even though Tree Configuration I has fewer trees than Tree Configuration II. This tree configuration is very helpful for station 59. A decrease in wind speed of 4.2 mph was recorded from Tree Configuration I and 6.4 mph from the 60 foot spacing. Its category is improved from 2 to 3, and the location now passes the BRA criteria while before it did not. The winds at station 66 did not change significantly, and it remained in Melbourne category 1 and above the BRA recommended maximum wind speeds. It is important to note that with every test, station 66 remained very high and also well

above the BRA standard, but that best results were achieved with Tree Configurations I and II. Station 12 had higher velocity winds with this tree configuration than with the other two of about 4 mph. The reason for this increase is probably not due to the existence of the trees but rather with the placement of the hot wire probe. Station 12 is located at a high wind shear area because of its proximity to a building corner. This means that small changes in placement of the probe could lead to significant differences in reported wind velocity.

7.3.3 Tree Configuration III

Tree Configuration III is shown in Figures 14, 19, and 20. Stations tested were the same as for Tree Configuration II: 9, 11, 12, 14, 58, 59, 62, and 66. All stations but 58 and 66 showed a decrease in wind speed from Tree Configuration II. Only station 66 had any real increase (about 1 mph) and this increase could probably be reduced by having a break in the line of trees along St. James Avenue at the corner of the John Hancock tower where station 66 is located. Of importance is that station 59 showed a further decrease of 3.7 mph from Tree Configuration II. The average 100 hour return period velocity is now 10.2 mph less than it was without any trees and has changed categories from 2 to 4. Also, this point is no longer above the BRA guideline. Of course, for all three tree configurations the results showed station 59 to under the BRA guideline, but tree Configuration III was the most effective in reducing the predicted pedestrian level wind velocities. The velocities at stations 11 and 12 have been decreased so that now both are in category 5.

7.4 SEASONAL EFFECTS

All the data has been reduced to determine the differences in predicted 100 hour return period winds in the various seasons. The seasons used are defined as follows: Winter; January, February, and March; Spring; April, May, and June; Summer; July, August, and September; and Fall; October, November, and December. As described in Appendix III, the data from Logan Airport (1945-1965) has bern used to obtain the annual and seasonal wind roses shown in Figures 21 to 25 and the Weibull coefficients given in Tables A1.1 to A1.5. In the figures, the distance out from the center is proportional to the frequency that the wind comes from each direction (the scale is indicated on each figure), and the circumferential lines show how often the wind occurs less than the indicated velocity.

The annual wind rose (Figure 21) shows that on an annual basis the wind comes from the west most of the time (68%). The summer wind rose (Figure 24) shows that the dominant winds in the summer are from the southwest. Similarly, Figure 22 indicates that in the winter the northwest winds are the most prevalent.

From Figures 23 and 25, it is clear that the spring and fall winds are transitional. Also note the much reduced east winds in the winter and the much increased east winds in the summer. The latter is probably due to the prevalence of easterly seabreezes in the summer. This probably would not be the case at a more inland site.

The average wind speed at Logan Airport from 1945 to 1965 was 11.2 mph at about 52 feet. In the winter it increased to 12.6 mph, and for the spring, summer and fall was 11.2, 9.7, and 11.4 mph respectively. On the other hand, if one uses the Weibull coefficients given in Tables A1.1 to A1.5 to calculate the one percent occurrence wind velocity at 4.5 feet at Logan Airport, one obtains values of 19.0, 19.7, 20.7, 16.1, and 18.8 mph for the annual, winter, spring, summer, and fall values respectively. Thus, while on the average the winds are fastest in the winter, at the one percent occurrence level they are fastest in the spring. Also note that one expects the average of average velocities for the seasons to be equal to the annual value, but that is not true for the one percent occurrence velocities. Further, the mathematics are such that it is not necessary that it be true.

Table 3 lists the Melbourne category of each station annually and for each season for all the configurations considered in both phases II and III. Any time the predicted velocity for a station exceeds the BRA criteria, there is a star beside the Melbourne category number. In general, the categories for winter, spring, and fall are the same and that for summer is greater (lower velocity) except when all are in category 1 or 5. At many stations, for one or two conditions the categories of winter and/or spring are the smallest (1 or 2) as might be expected.

The "equivalent average" described above was calculated for each station and station condition to find the categories given in Table 3. Examination of that data brought out two significant points: 1) Except for two station conditions, 12 for Tree Configuration III and 48 for the 50 foot spacing, predicted velocities for summer were always less than for the other seasons. The category of station 12 for that condition is 5 and that of station 48 is 2, but for station 48 the difference in predicted one percent return period velocity between fall and summer is only 0.1 mph. 2) At a significant number of station conditions, the predicted velocities for winter were greater than those for spring. These included stations 1, 7, 31, 33, 52, 66, 87, 94, and 104 for existing conditions, stations 12, 14, 15, 22, 24, 26, 28, 110, 111, 31, 33, 52, 66, 94, and 104 for the 50 foot spaced towers, stations 12, 14, 15, 19, 22, 24, 26, 28, 110, 111, 31, 33, 52, 94, and 104 for the 60 foot spacing without trees, stations 11, and 14 for tree configuration I, and stations 11, 14, and 66 for tree configurations II and III. In general, the differences were less than one mph and the maximum difference was

2.2 mph at station 104 for the 50 foot spaced towers.

8. CONCLUSIONS

The proposed change in tower separation from 50 to 60 feet has only one significant effect: The winds in the two courtyards will be reduced. Also, the predicted 100 hour return period annual winds at station 59 are reduced back to nearly the same value determined for the existing conditions. The three tree configurations will have the effect of reducing the winds at stations 11, 12, 14, 58, and 59; the more trees, the greater the reduction. Of importance, is the fact that station 59 with the maximum number of trees went from Melbourne category 1 and above the BRA standard to Melbourne category 3 and below the BRA standard. Seasonal effects were investigated and most stations were found to follow the same trends shown in the data from Logan Airport with respect to the annual results.

REFERENCES

1. Campbell, G.S. and Standen N.M., "Progress Report II on Simulation of Earth's Surface Winds by Artificially Thickened Wind Tunnel Boundary Layers," Laboratory Technical Report LTR-LA-37, National Aeronautical Establishment of Canada, July 1969.
2. Cohen, H., McLaren, T.I., Moss, S.M., Petyk, R., and Zube, E.H., "Pedestrians and the Wind Environment" University of Massachusetts/ Amherst, Amherst, Massachusetts. Publication No. UMASS/IME/R-77/13 December, 1977.
3. Counihan, J., "Adiabatic Atomospheric Boundary Layers: A Review and Analysis of Data from the Period 1880-1972," Atmospheric Environment, Vol 9, pp 871-905, Pergamon Press 1975.
4. Davenport, A.G., "The Dependence of Wind Loads on Meteorological Parameters," Proceedings of Int. Research Seminar on Wind Effects on Building and Structures, Vol 2, Ottawa, Canada, September 1967.
5. Davenport, A.G., "An Approach to Human Comfort Criteria for Environmental Wind Conditions," Proceedings, Colloquium on Building Climatology, Stockholm, Sweden, 1972.
6. Davenport, A.G. and Isyumov, N., "The Application of the Boundary Layer Wind Tunnel to the Prediction of Wind Loading," Proceedings of Int. Seminar on Wind Effects on Buildings and Structures, Ottawa, Canada, September 1967.
7. Durgin, F.H., Chan C-M, "A Wind Tunnel Study of Pedestrian Level Winds for the Proposed New England Life Complex, Boston. Phase Two: The Hot Wire Results", Wright Brothers Wind Tunnel Report WBWT TR 1205, M.I.T. Dept. of Aero. and Astro., Cambridge, Mass., 1984.
8. Durgin, F.H., "Measuring Facade Pressures at the Wright Brothers Memorial Wind Tunnel," Proceedings Fourth U.S. National Conference on Wind Engineering Research, Un. of Washington, Seattle, Washington, U.S.A. July,1981.
9. Epstein, R., "Wind Tunnel Simulation of the Atmospheric Boundary Layer," S.M. thesis, M.I.T. Dept. of Aero. and Astro., Cambridge, Mass., May 1975.
10. Grip, R.E., "An Investigation of the Erosion Technique for the Evaluation of Pedestrian Level Winds in the Wind Tunnel" Wright Brothers Memorial Wind Tunnel Report WBWT TR 1161, M.I.T. Dept of Aero. and Astro, Cambridge, Mass., June 1982.
11. Fortier, L.J., "Pedestrian Wind Environment at Copley Place, Boston, Massachusetts," Bolt Beranek and Newman, Cambridge, Massachusetts, Report No. 4415, June 1980.
12. Gumbel, E.J., STATISTICS OF EXTREMES, Columbia University Press NY, NY, 1958, pp.136-140.
13. Hunt, J.C.R., Poulton, E.C., and Mumford, J.C., "The Effects of Wind on People; New Criteria Based on Wind

Tunnnel Experiments," Building and Environment, II, 1976, pp. 15-28.

14. Lawson, T.V., "The Wind Environment of Buildings: A Logical Approach to the Establishment of Criteria," Report No. TVL 7321, Univ. of Bristol, Bristol, England, Dept. of Aerodynamics Engineering, 1973.
15. Melbourne, W.H., "Criteria For Environmental Wind Conditions," Journal of Industrial Aerodynamics, Vol.3 1978, pp.241-249.
16. Melbourne, W.H., and Joubert, P.N., "Problems of Wind Flow at the Base of Tall Buildings," Proceedings of the Third International Conference on Building and Structures, Tokyo, Japan, 1971.
17. Murakami, S., Uehara, K., and Deguchi, K., "Wind Effect on Pedestrians: New Criteria Based on Outdoor Observation of Over 2000 Persons," Proceedings of the Fifth International Conference, Vol 1, Fort Collins, Colorado, USA, July 1979.
18. Penwarden, A.D., "Acceptable Wind Speeds in Towns," Building Science, Vol. 8 pp 259-267, 1973
19. Penwarden, A.D., and Wise, A.F.E., "Wind Environment Around Buildings," Building Research Establishment Digest 1975.
20. Peterka, J.A., Cermak, J.E., "Wind Tunnel Study Of International Place, Boston, Part 2: Quantative Pedestrian Flow Analysis," Fluid Dynamics and Diffusion Laboratory, Department of Civil Engineering, Colorado State University, Fort Collins, Colorado. Report 4125C, May, 1984.
21. Radovsky, S., and Durgin, F.H., "Wind Tunnel Study of Pedestrian Level Winds at Battery Park City, New York, New York," Wright Brothers Memorial Wind Tunnel, WBWT-TR 1097, M.I.T. Dept. of Aero. and Astro., Cambridge, Mass., 1976.
22. Rodriquez, T.A. Jr., and Durgin, F.H., "A Wind Tunnel Study of Pedestrian Level Winds at The Proposed New England Life Building" Wright Brothers Wind Tunnel Report WBWT TR 1188, M.I.T. Dept. of Aero. And Astro., Cambridge, Mass., May 1983.
23. Van Der Hoven, "Power Spectrum of Horizontal Wind Speed in the Frequency Range from 0.0007 to 900 Cycles per Hour," J. of Meteorology, Vol 14, pp. 16, 1967.

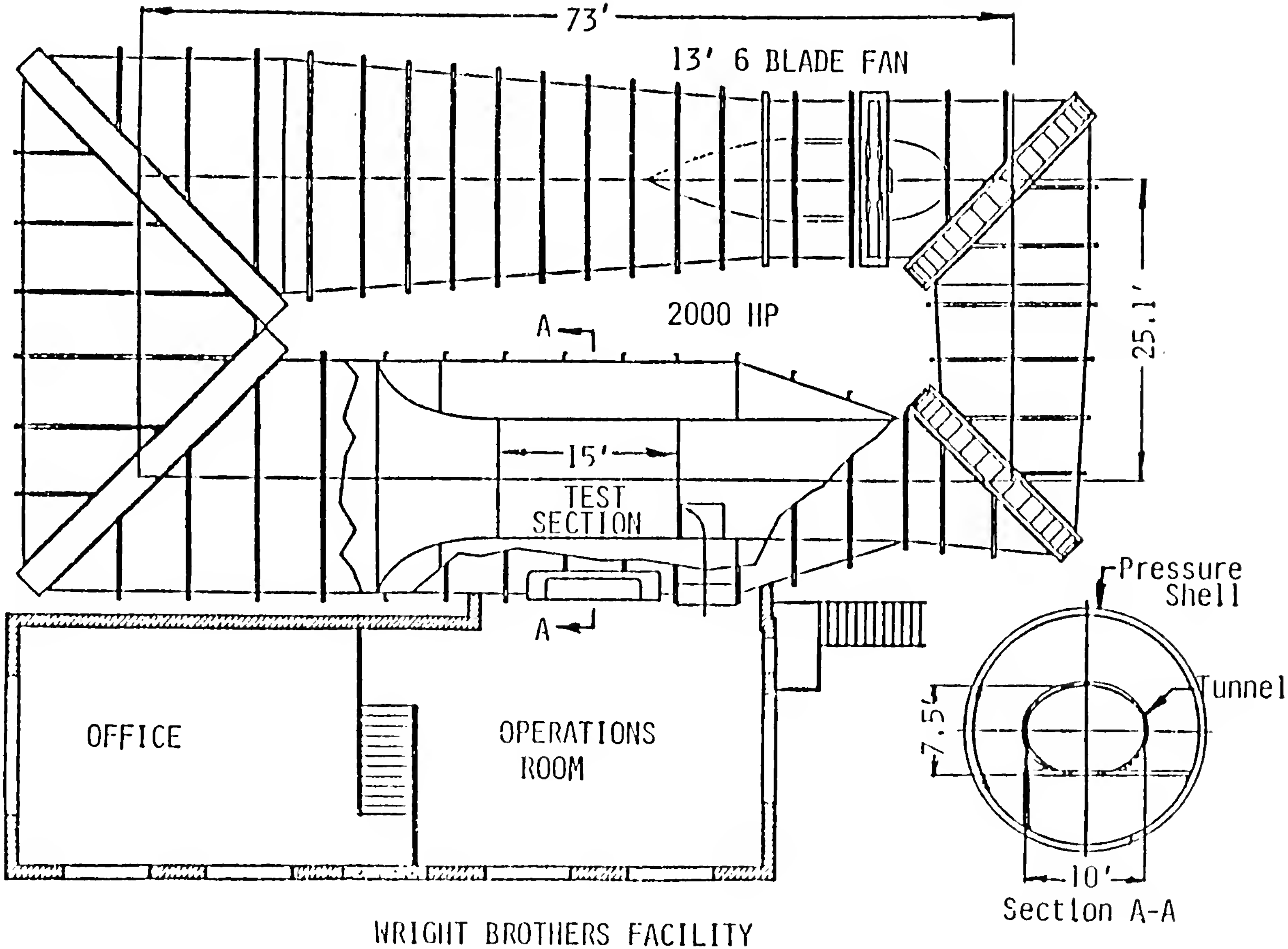


Figure 1. Schematic Diagram of Wright Brothers Facility

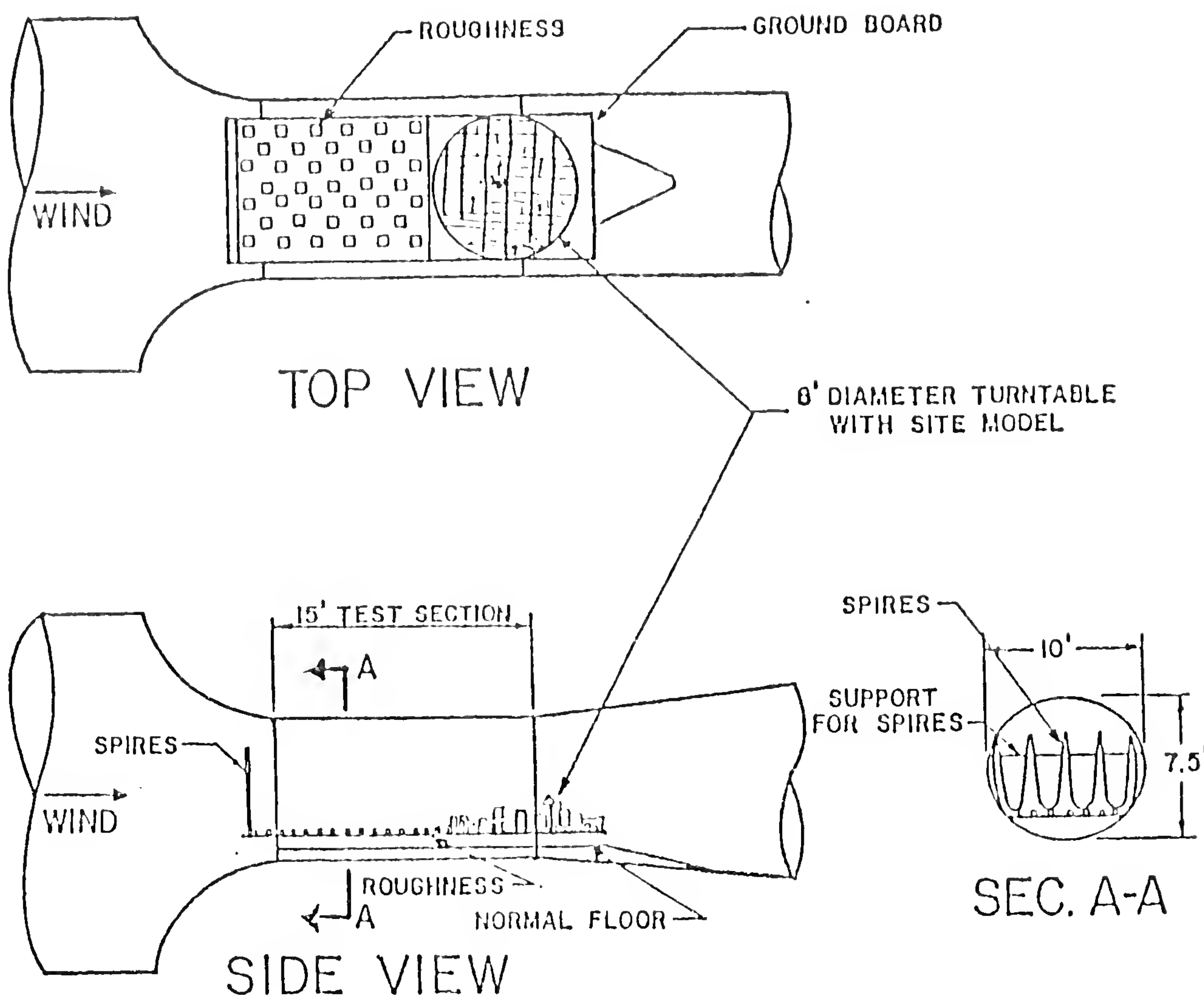


Figure 2. Schematic Diagram of Boundary Layer Simulation

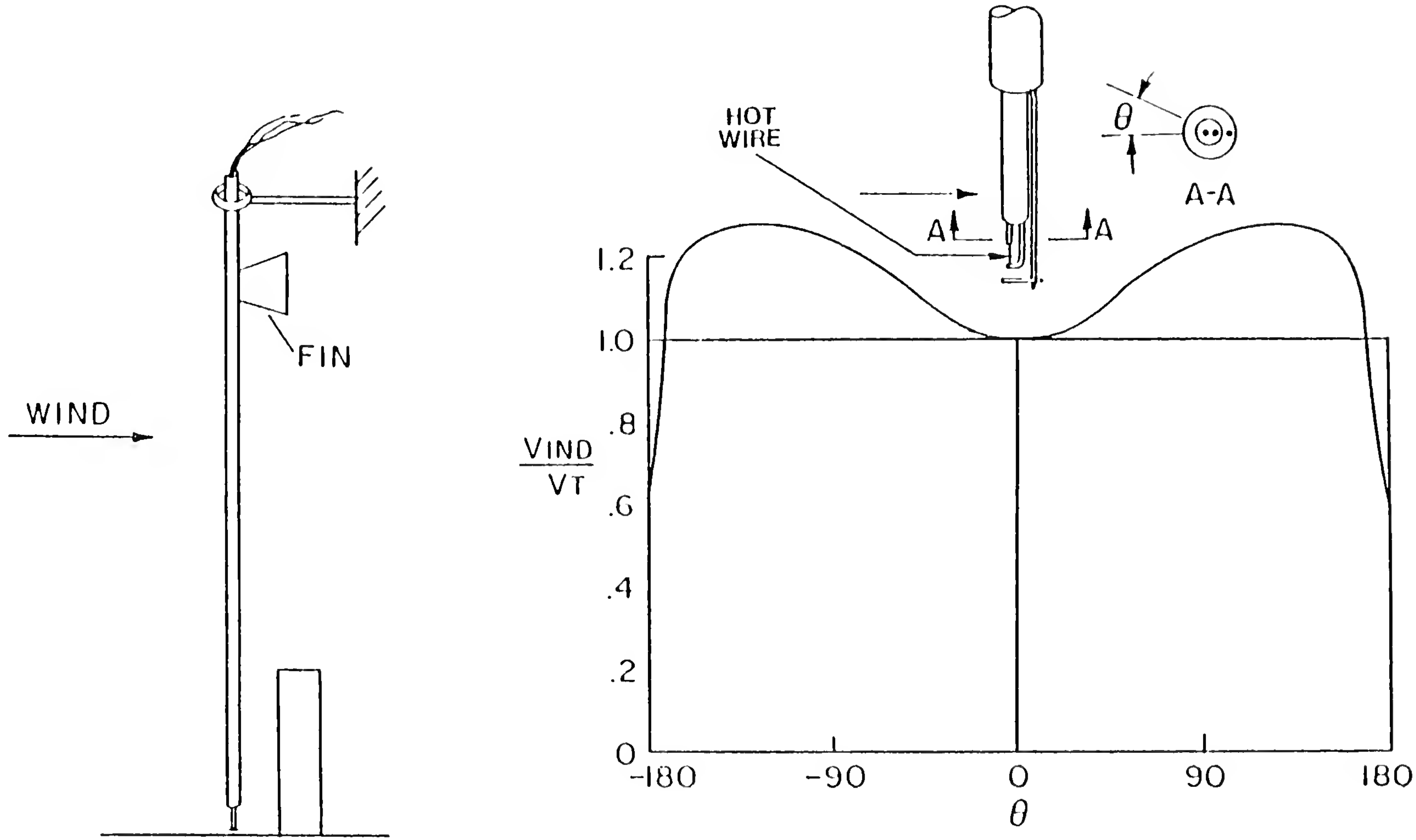


Figure 3. GROUND WIND HOT WIRE SET UP AND ANGLE CALIBRATION

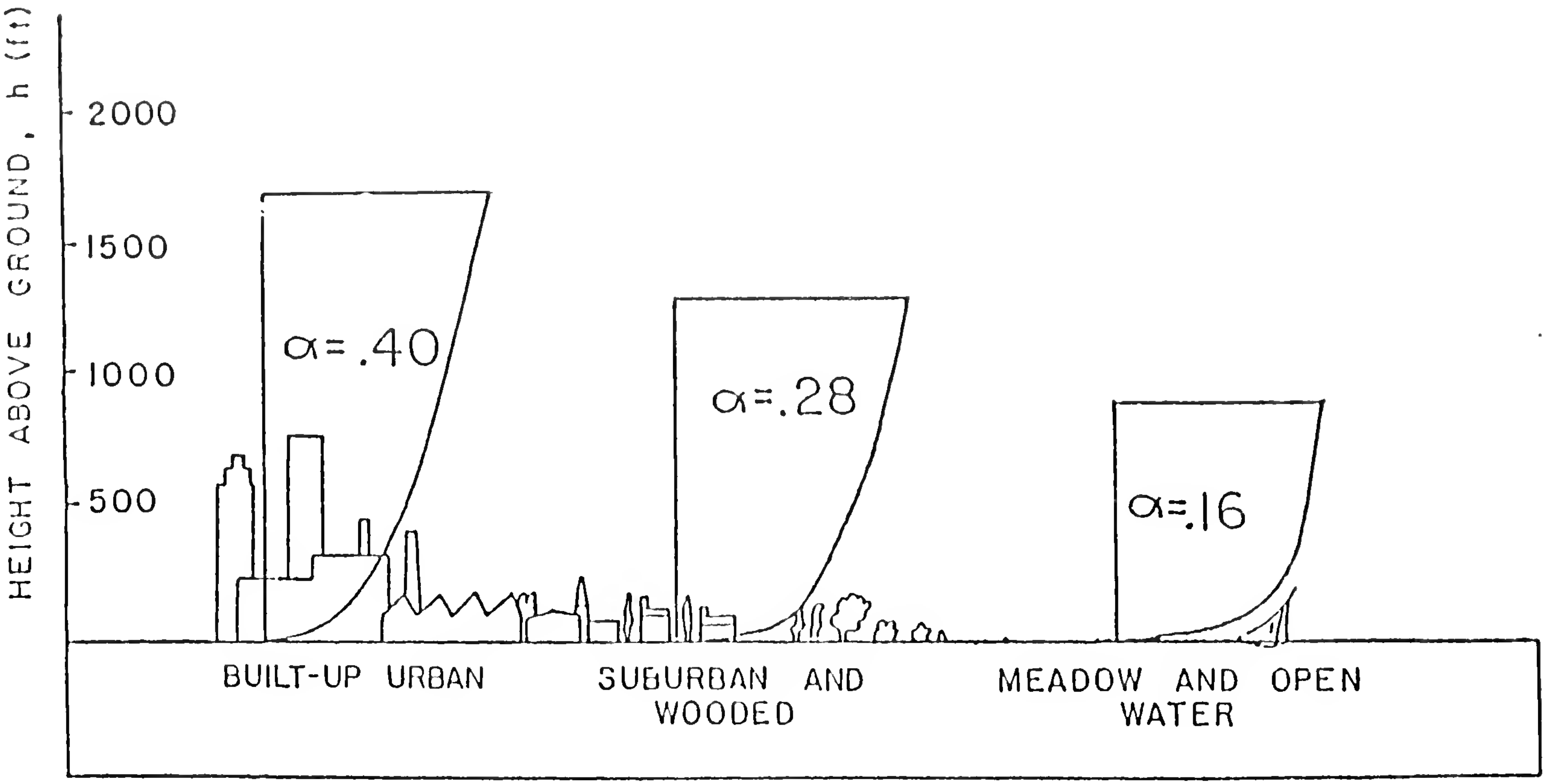


Figure 4. Types of Earth's Boundary Layer after Davenport

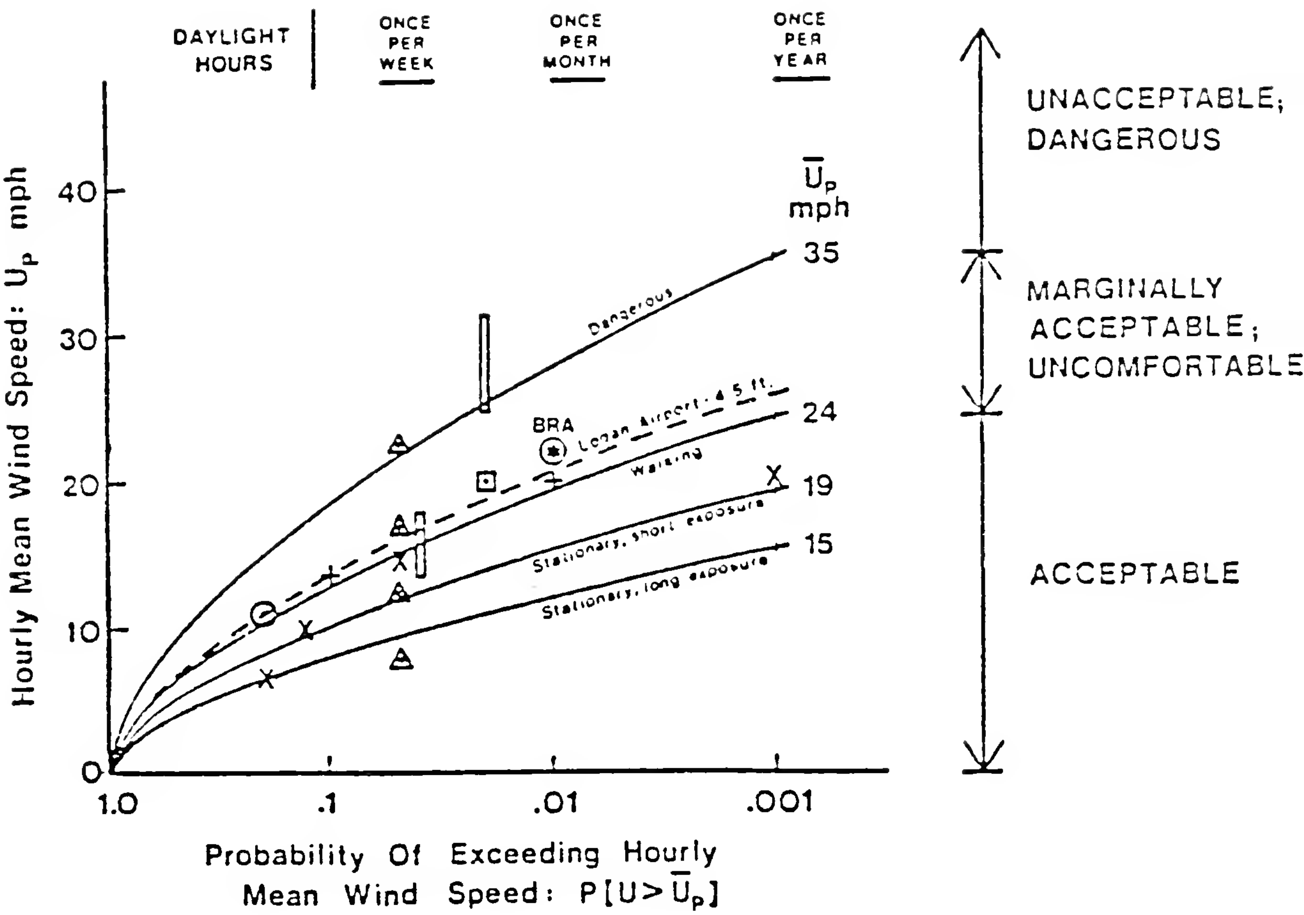


Figure 5. Pedestrian Level Wind Criteria Graph

		SYMBOL
Conditions at Logan Airport		- - -
Criteria		
MELBOURNE [15]		———
DAVENPORT [5]		
Acceptable for:		
Walking fast	If $P[\bar{u} > 22.4] < 0.05$	△
Strolling	If $P[\bar{u} > 16.8] < 0.05$	△
Standing, Sitting Short Exposure	If $P[\bar{u} > 12.3] < 0.05$	△
Standing, Sitting Long Exposure	If $P[\bar{u} > 7.8] < 0.05$	△
PENWARDEN and WIDE [19]		
Acceptable	If $P[\bar{u} > 11.2] < 0.2$	⊙
LAWSON [14]		
Acceptable	If $P[\bar{u} > 13.4 \text{ to } 17.8] < 0.04$	═
Unacceptable	If $P[\bar{u} > 24.6 \text{ to } 31.3] < 0.02$	═
HUNT, POULTON and MUMFORD [13]		
Acceptable for Strolling	If $P[\bar{u} > 13.4] < 0.1$	+
Acceptable for Walking	If $P[\bar{u} > 20.1] < 0.01$	+
RADOVSKY and DURGIN [21]		
Acceptable	If $P[\bar{u} > 20.1] < 0.02$	⊡
COHEN et al		
Unacceptable - limit for safety	If $P[\bar{u} > 20] < 0.001$	X
Acceptable for: Walking	If $P[\bar{u} > 14] < 0.05$	X
Strolling (short exposure)	If $P[\bar{u} > 8] < 0.10$	X
Sitting (long exposure)	If $P[\bar{u} > 5] < 0.20$	X
BRA Guideline*	$P[\bar{u} > 22] < 0.01$	⊛

*Converted to average hourly winds.
ALL velocities in mph

Figure 6. Legend for Pedestrian Level Wind Criteria Graph

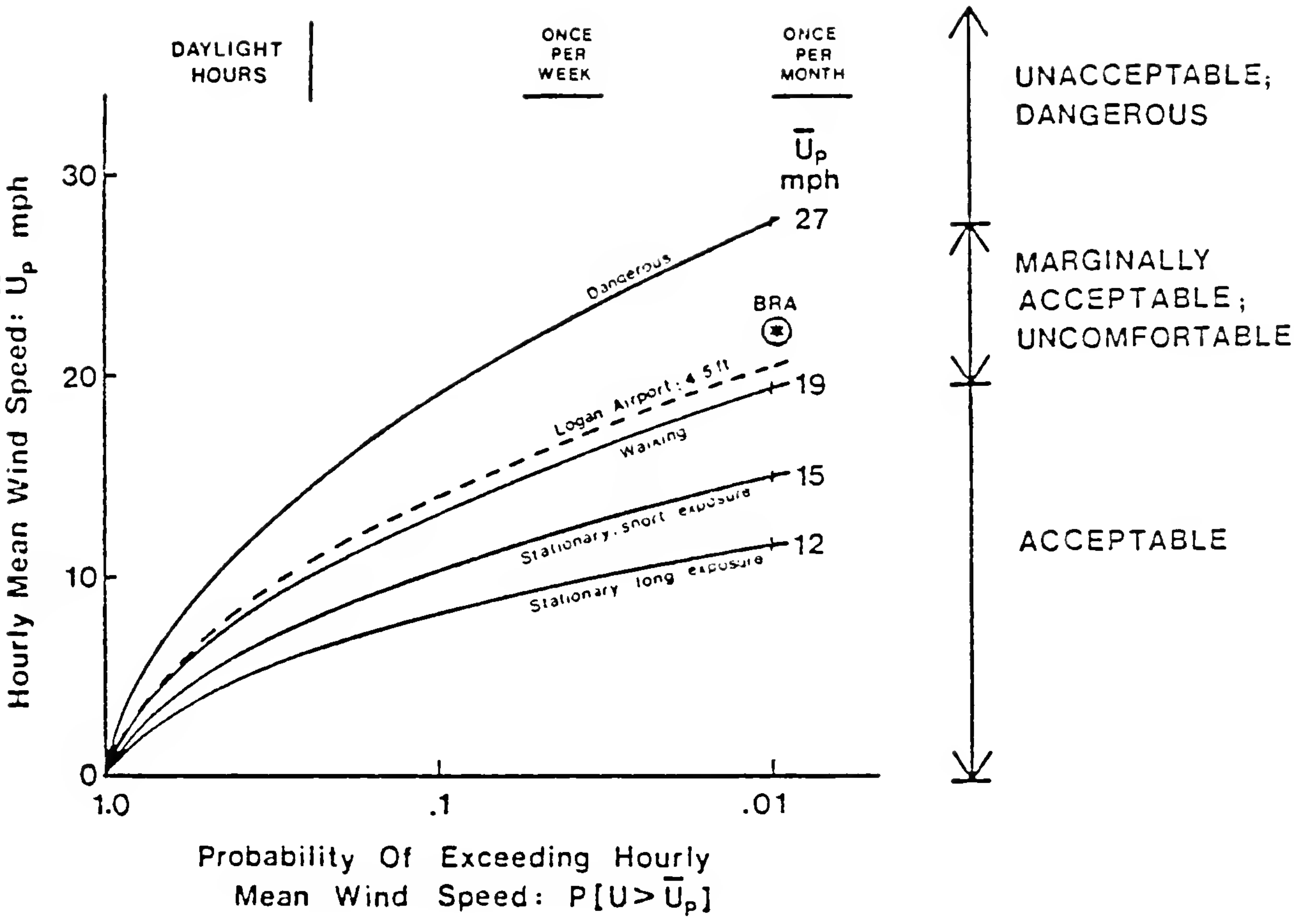


Figure 7. Melbourne's Criteria for Average Winds

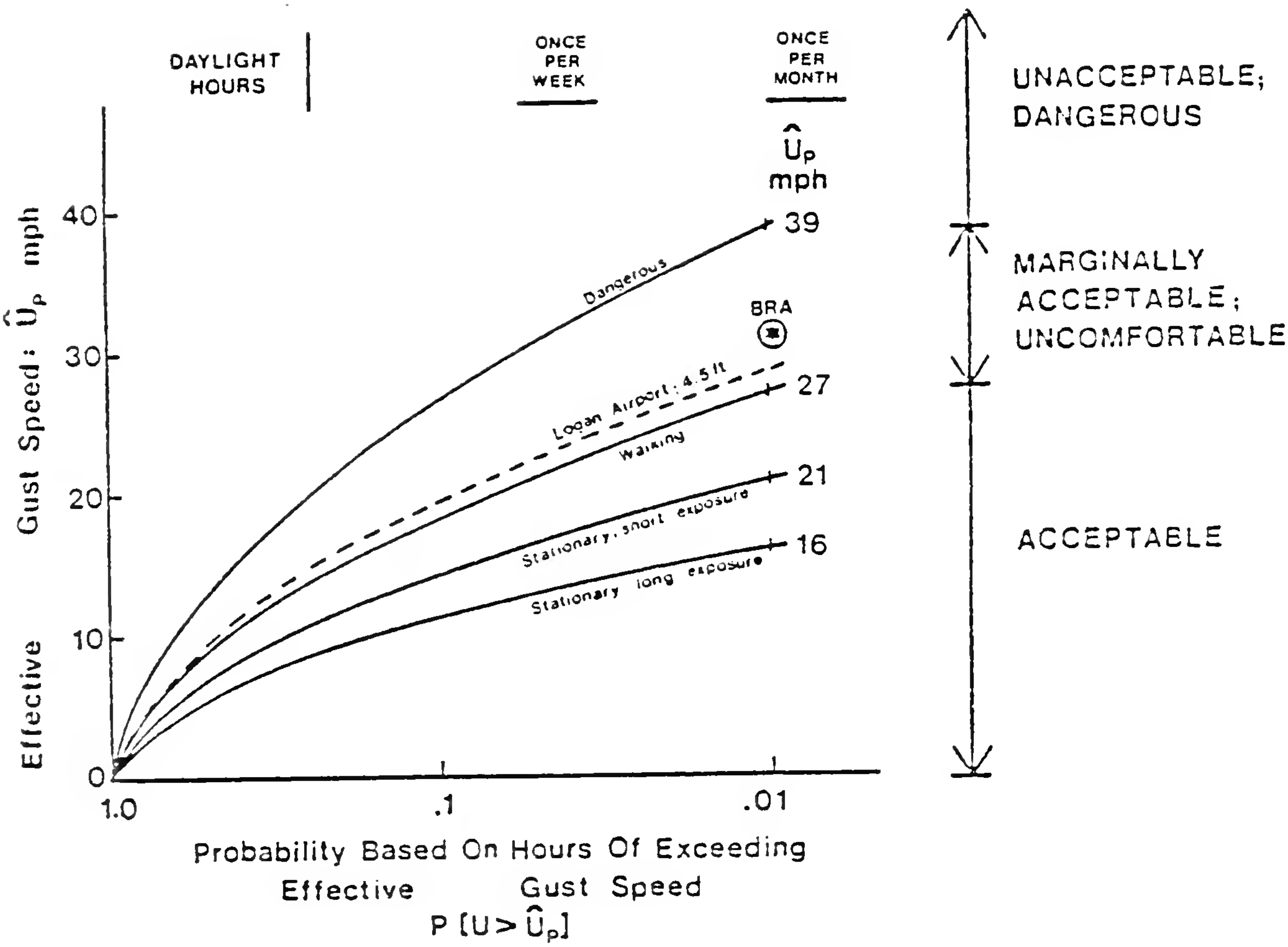


Figure 8. Melbourne's Criteria for Effective Gusts

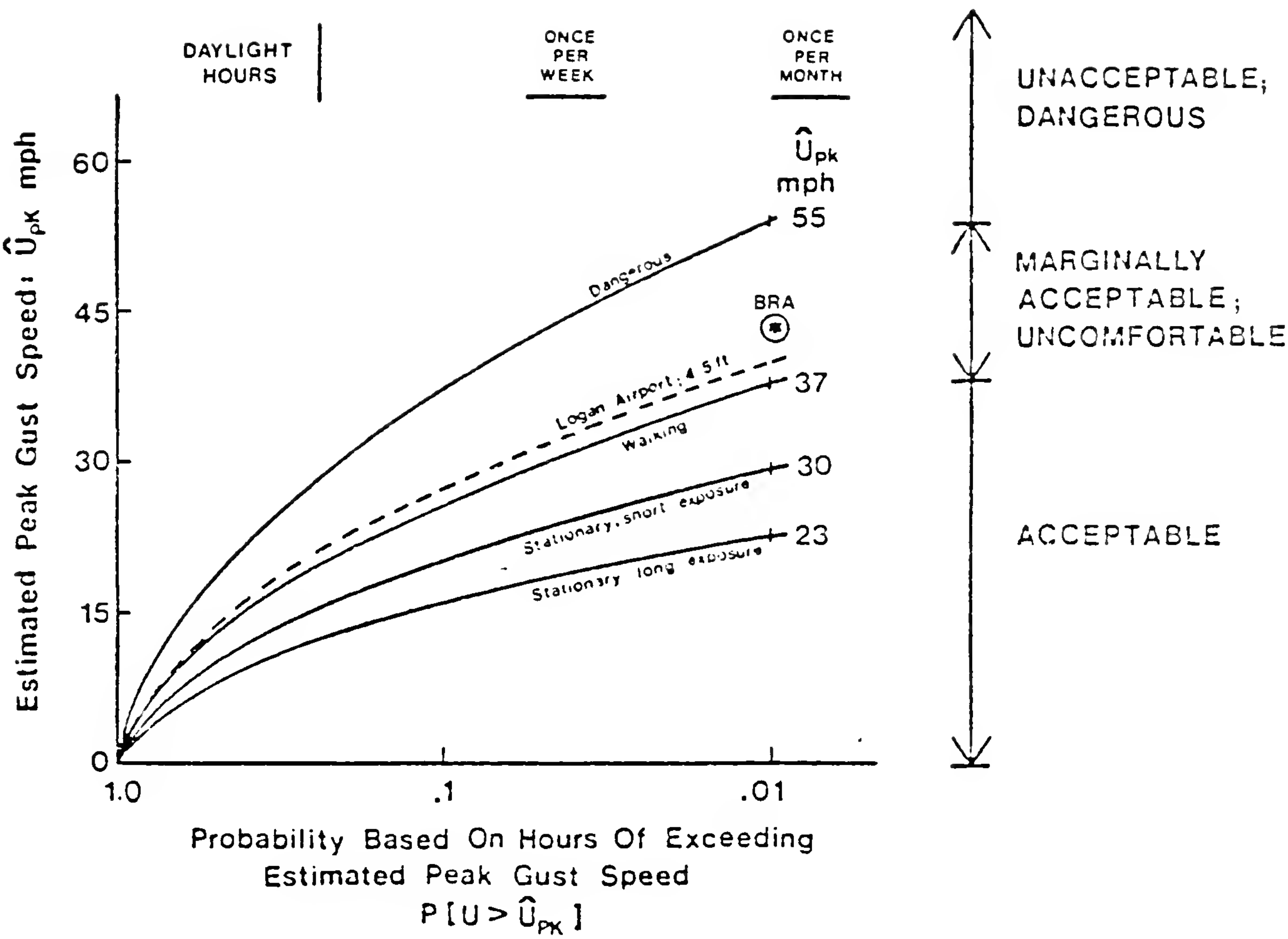
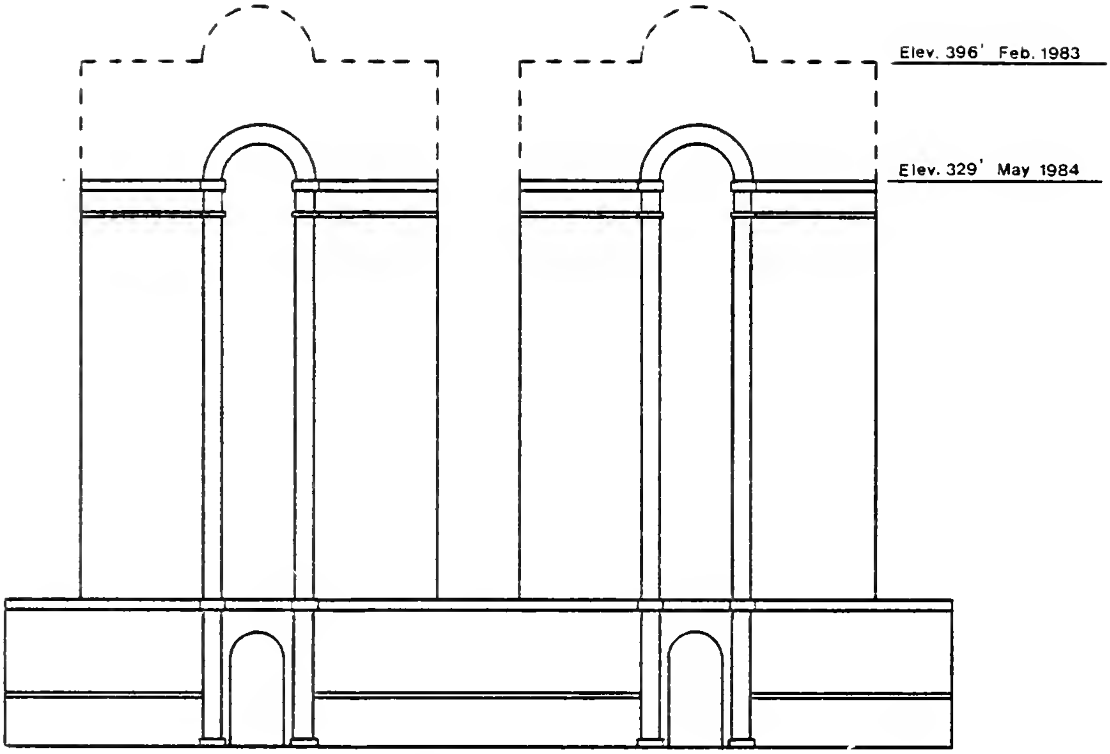
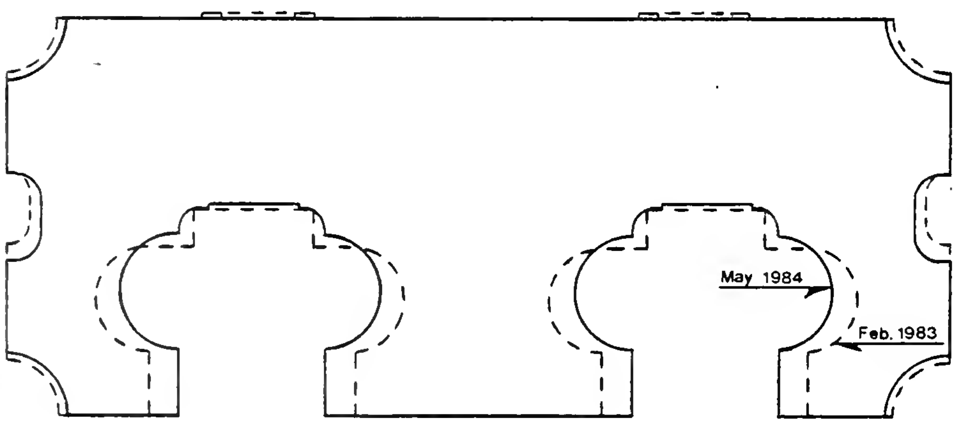


Figure 9. Melbourne's Criteria for Peak Gusts



FRONT VIEW



PLAN VIEW

Figure 10. Change in building design from Feb. 1983 to May 1984

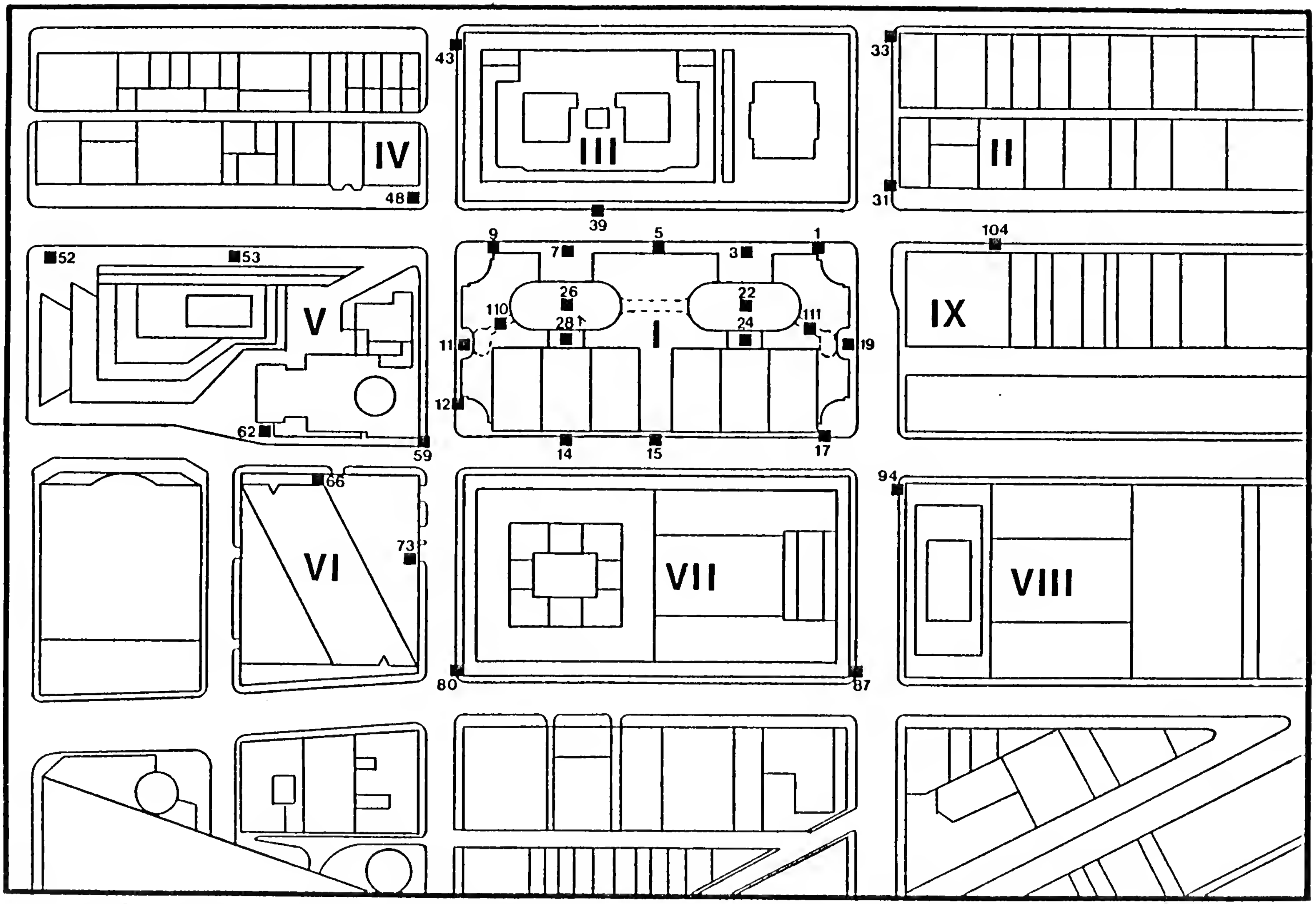


Figure 11. Map of New England Life area with the Locations of Stations Used in the Tests

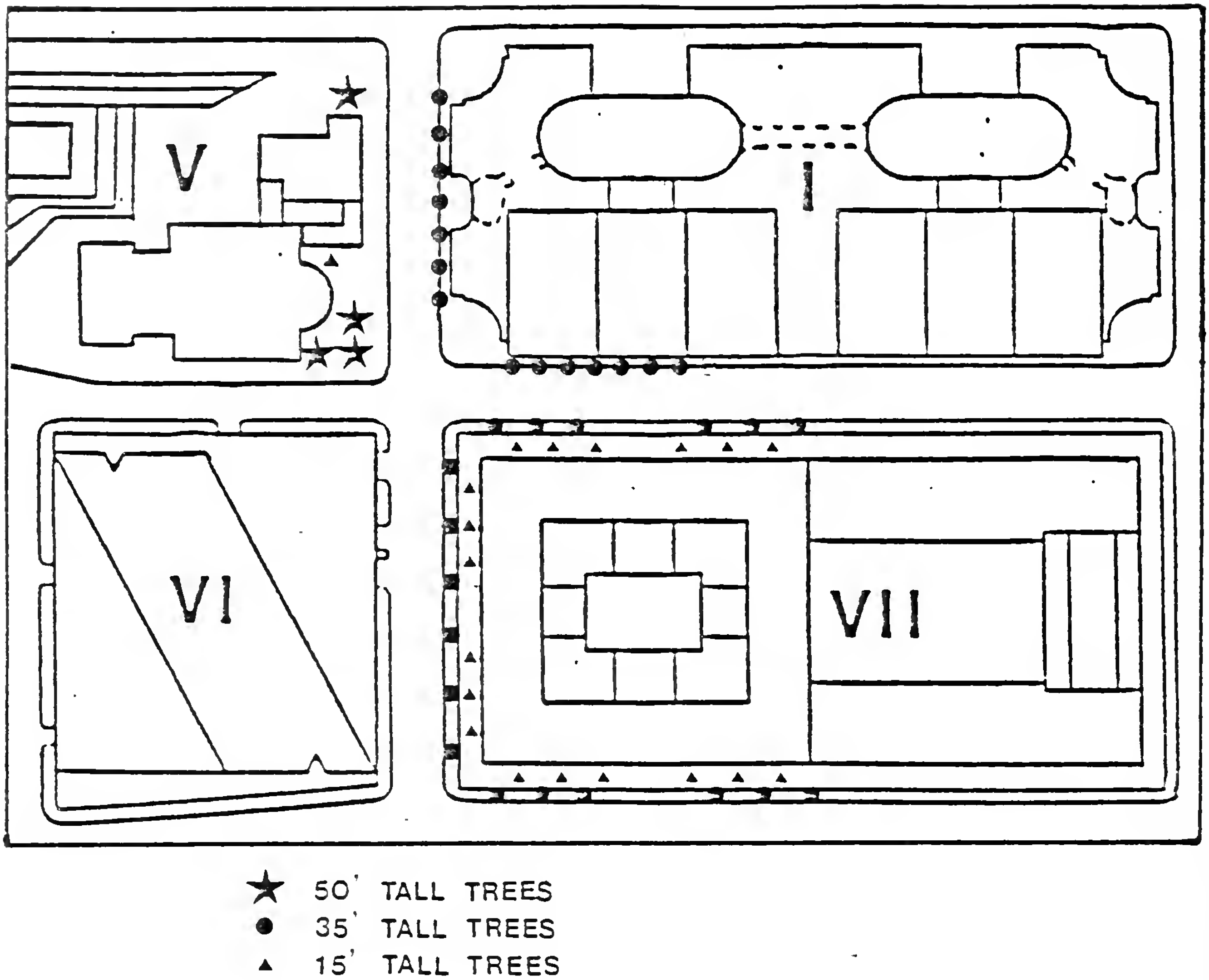


Figure 12. Location of Trees for Tree Configuration I

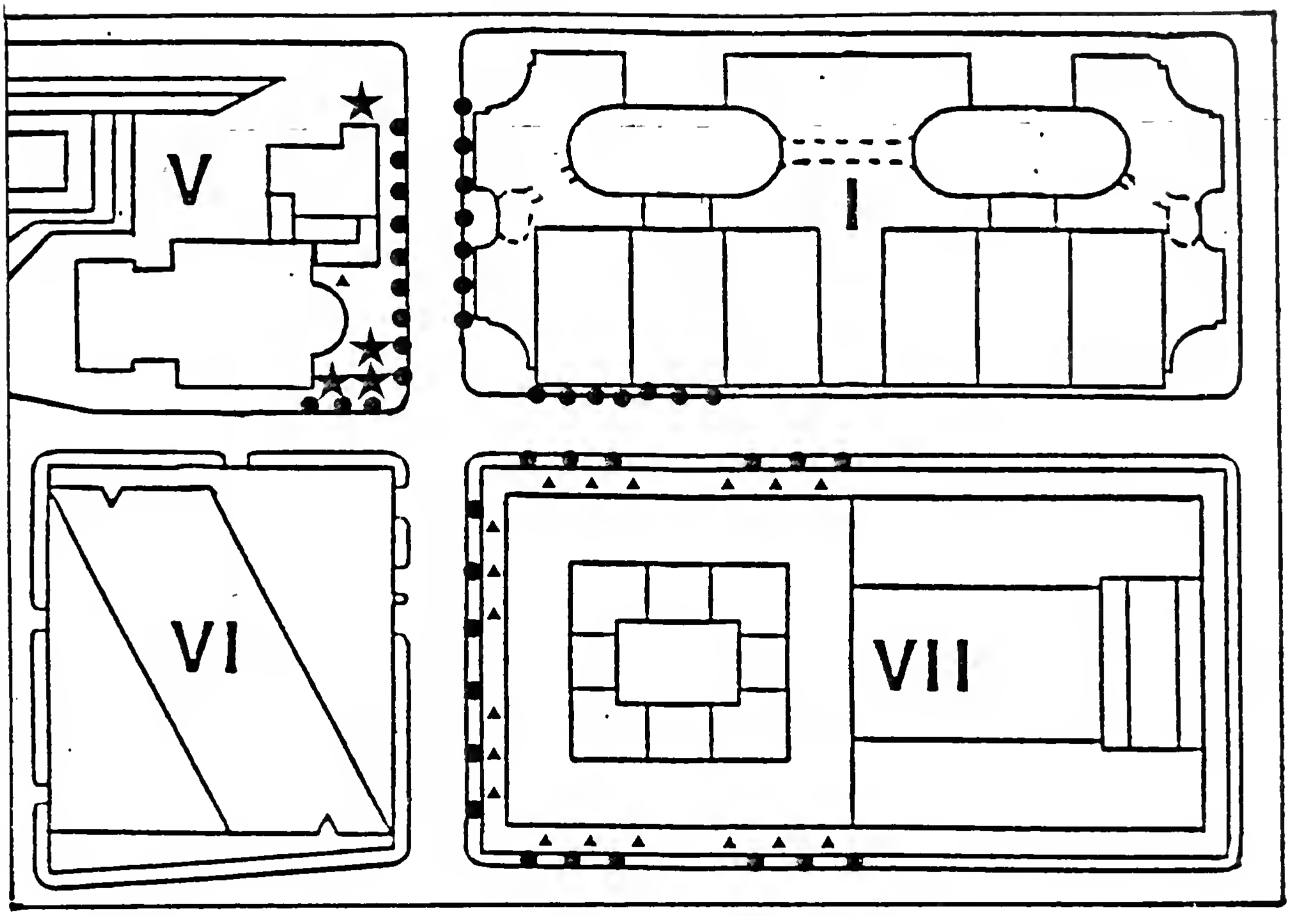


Figure 13. Location of Trees for Tree Configuration II

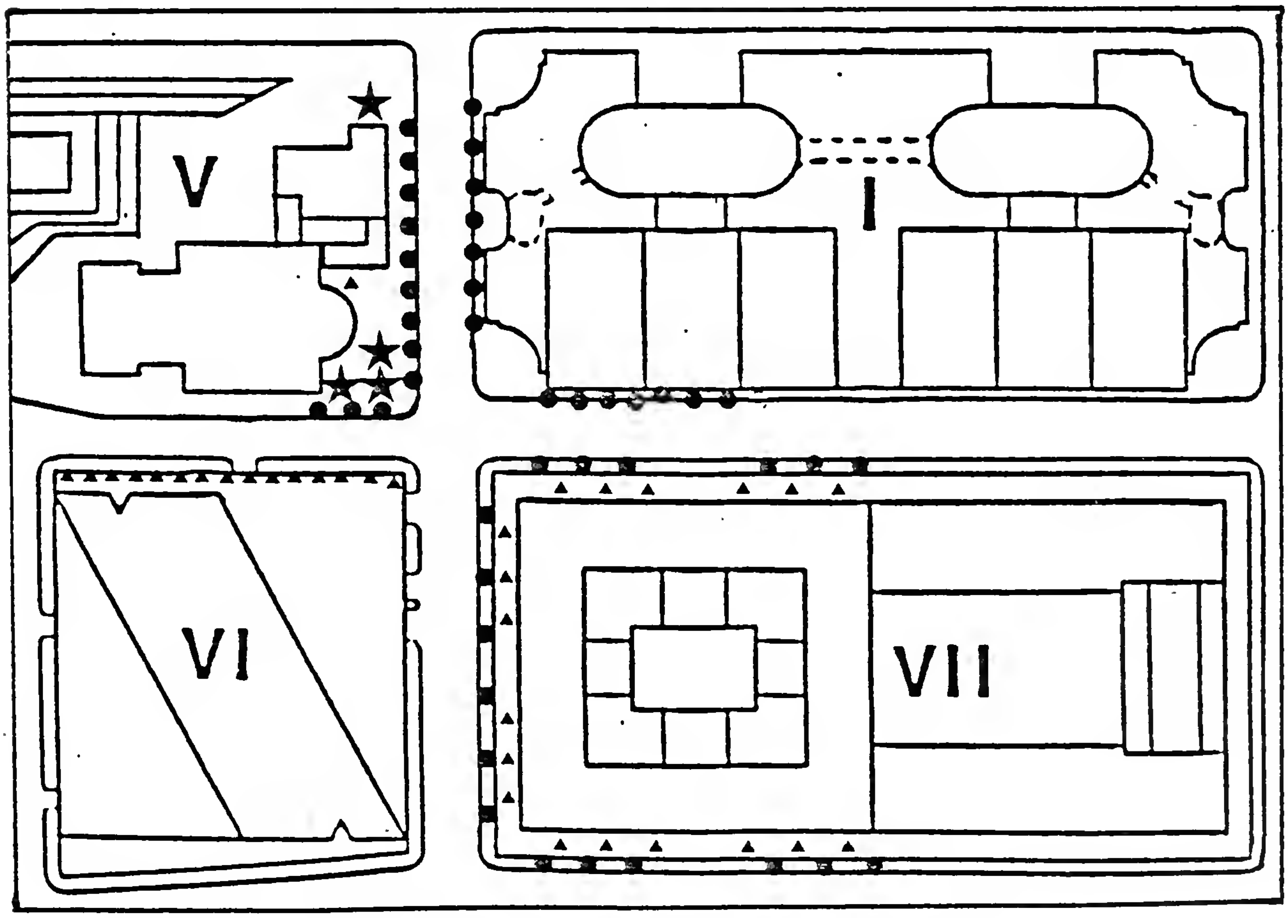


Figure 14. Location of Trees for Tree Configuration III

This page purposely left blank.

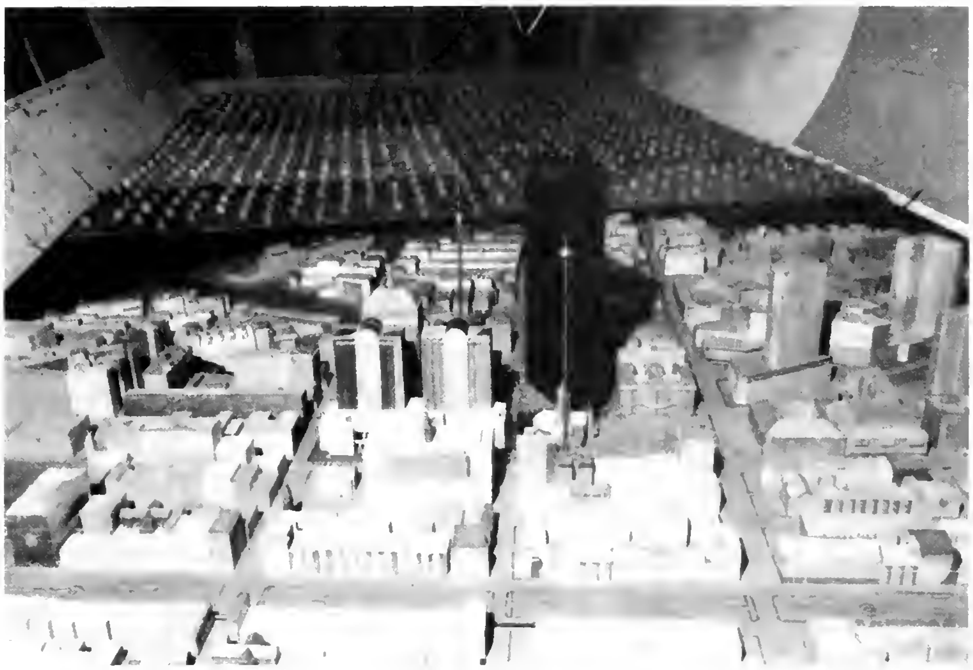


Figure 15. Model City in the Wind Tunnel

Figure 16. Towers of the NEL Complex Separated by 60 ft.

This page purposely left blank.

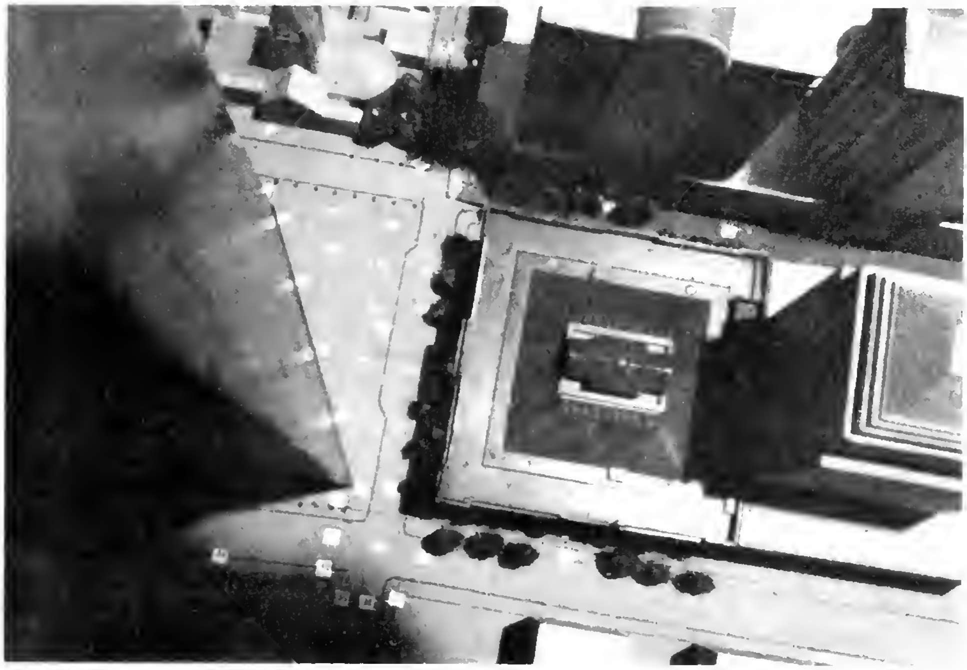


Figure 17. Tree Configuration I

Figure 18. Tree Configuration II

This page purposely left blank.

Figure 19. Tree Configuration III

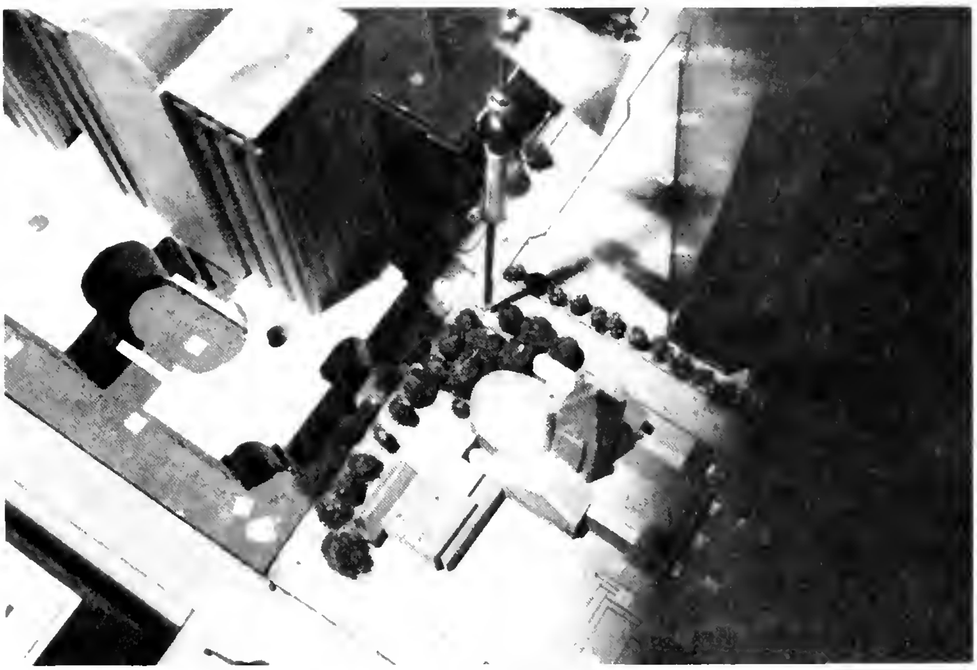


Figure 20. Tree Configuration III with Hot Wire Ready for Testing at Station 59

This page purposely left blank.

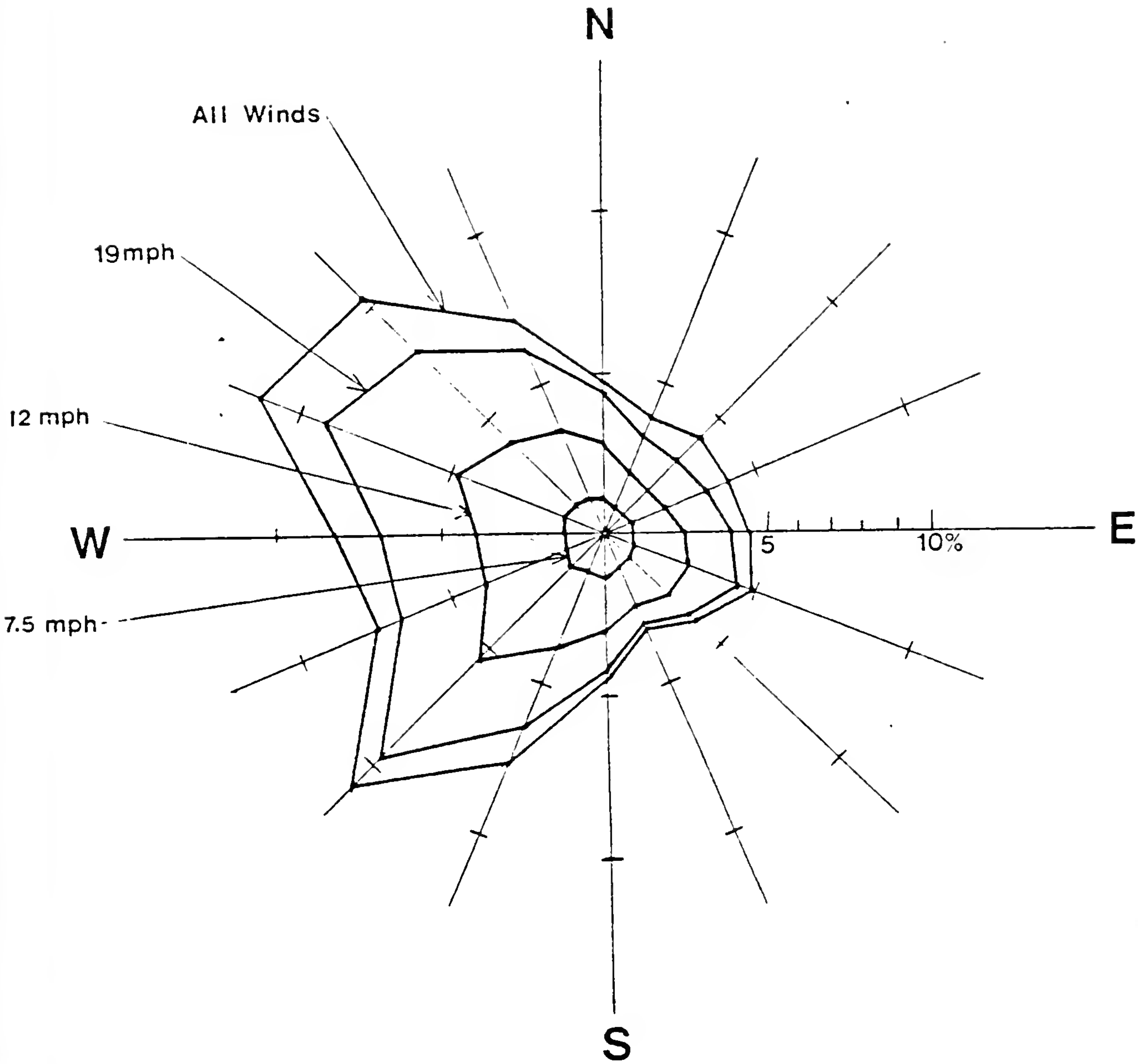


Figure 21. Boston wind rose for the year
Surface data obtained from Logan Airport 1945-1965

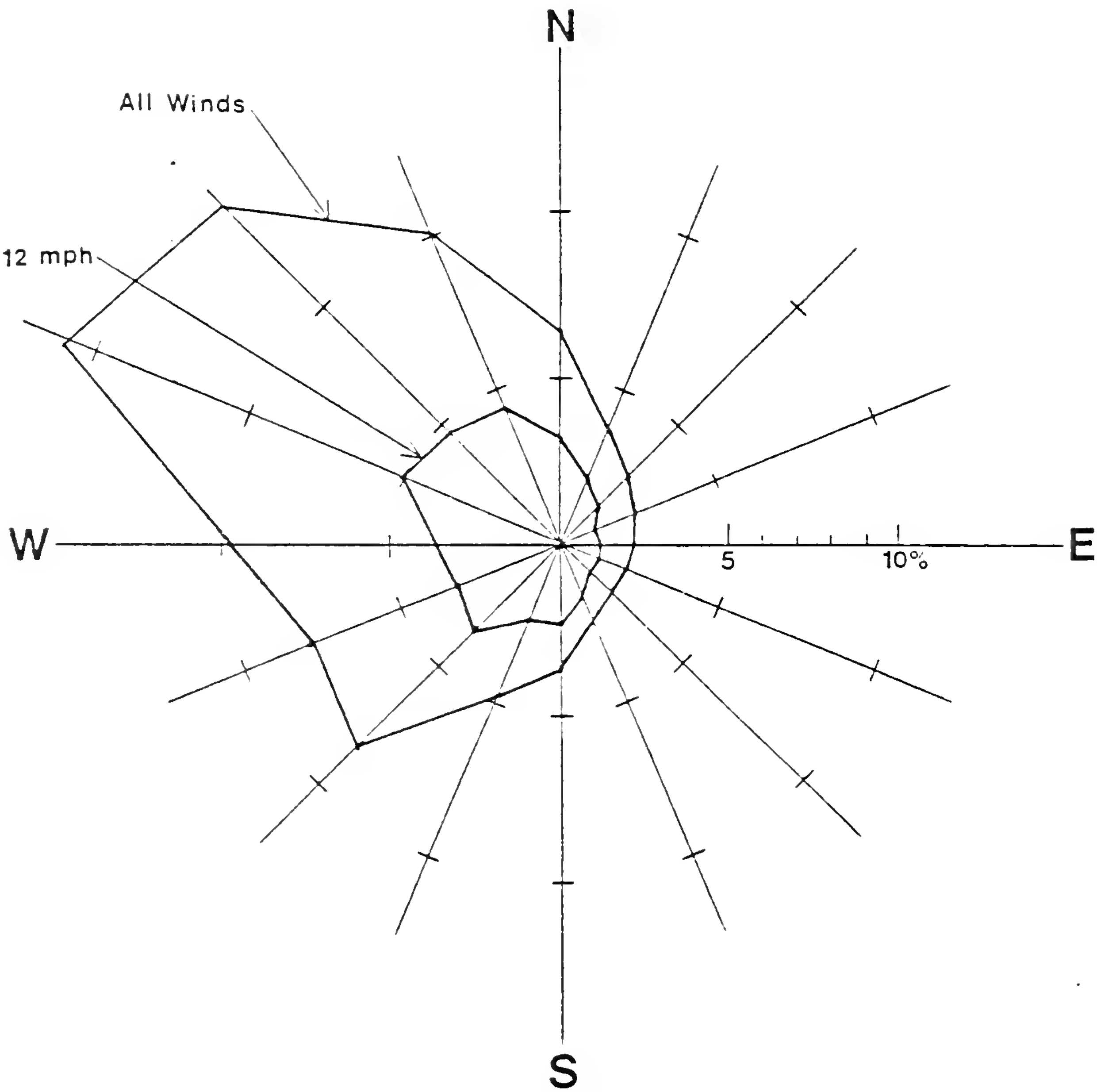


Figure 22. Boston wind rose for the Winter (December, January, February)
Surface data obtained from Logan Airport 1945-1965

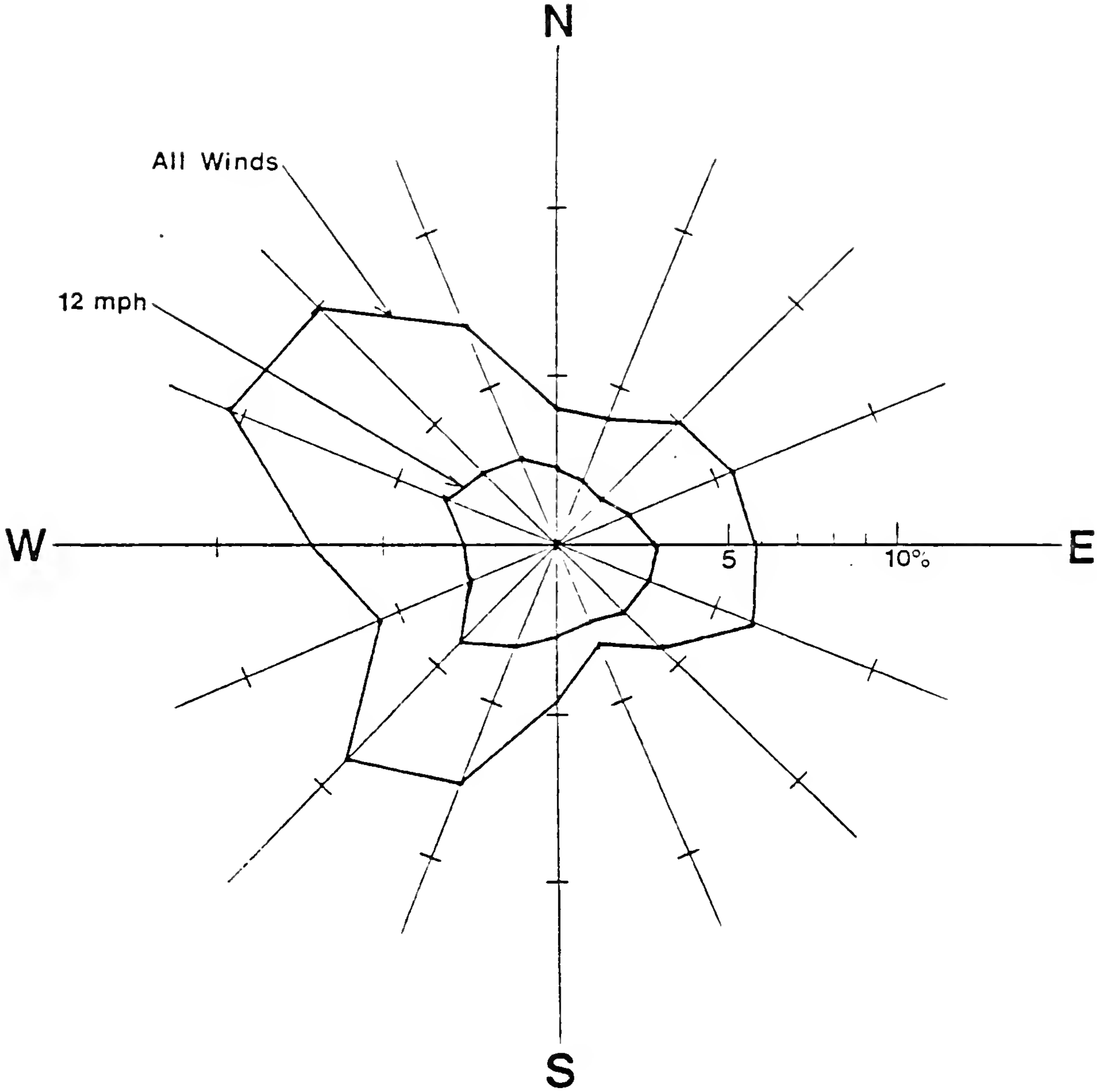


Figure 22. Boston wind rose for the Spring (March, April, May) Surface data obtained from Logan Airport 1945-1965

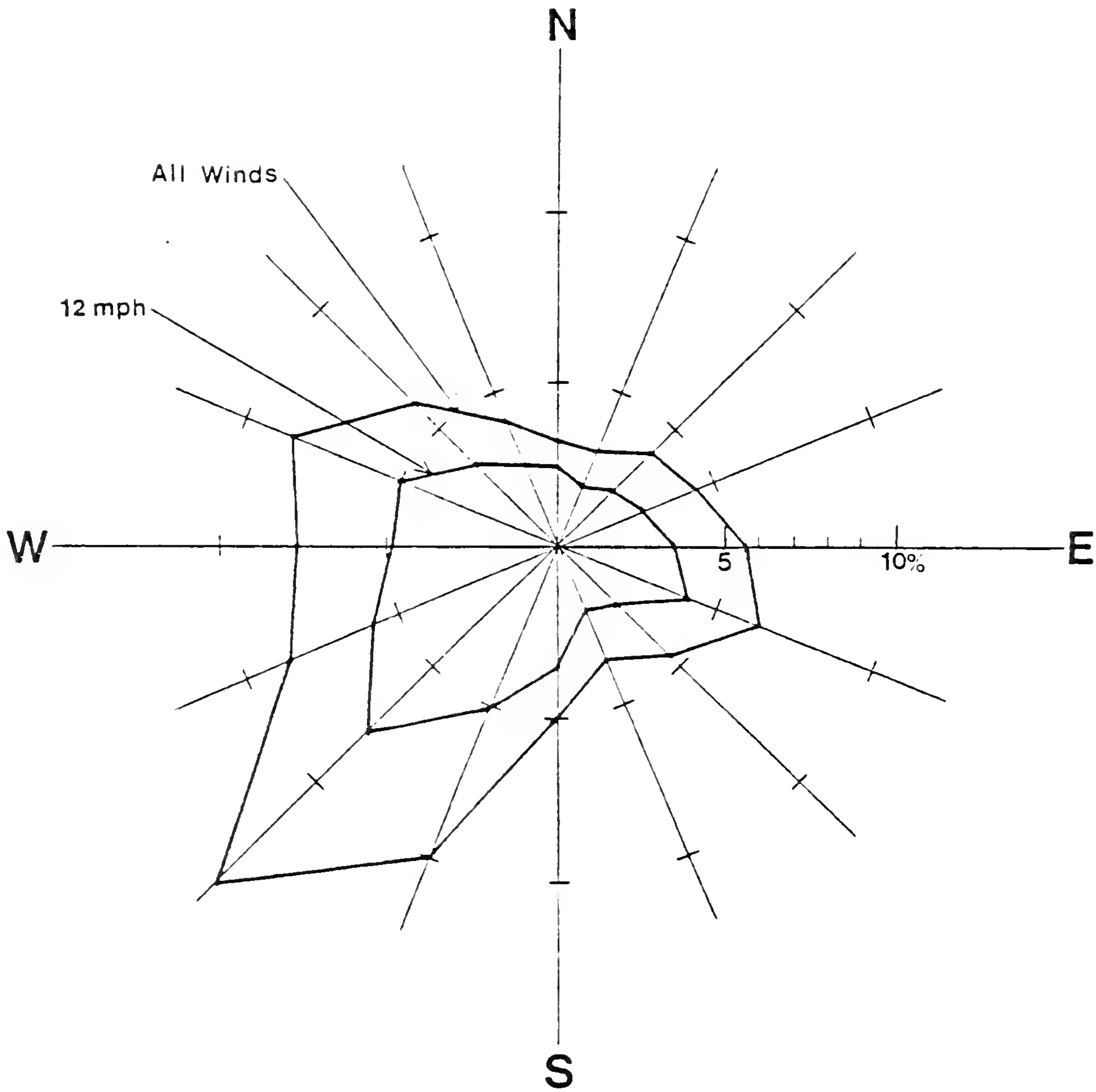


Figure 24. Boston wind rose for the Summer (June, July, August) Surface data obtained from Logan Airport 1945-1965

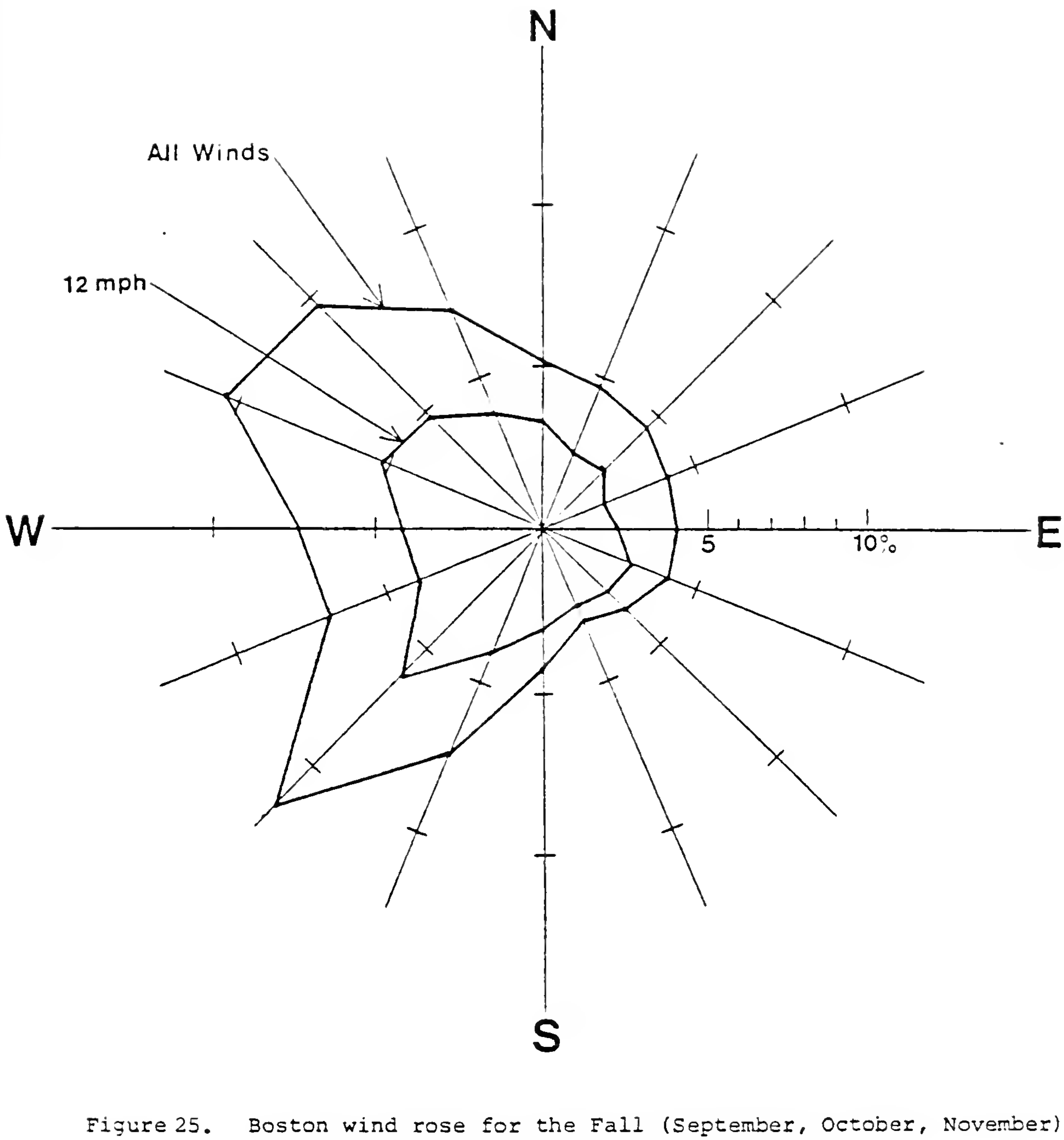


Figure 25. Boston wind rose for the Fall (September, October, November) Surface data obtained from Logan Airport 1945-1965

Table 1. Beaufort Wind Scale for Pedestrians after Penwarden

Beaufort Number	Description of Wind	Speed (m/sec)*	Speed (mph)*	Description of Wind Effects
0	Calm	Less than 0.4	Less than 0.9	No noticeable wind
1	Light airs	0.4 - 1.5	0.9 - 3.4	No noticeable wind
2	Light breeze	1.6 - 3.3	3.5 - 7.4	Wind felt on face
3	Gentle breeze	3.4 - 5.4	7.5 - 12.1	Wind extends light flag Hair is disturbed Clothing flaps
4	Moderate breeze	5.5 - 7.9	12.2 - 17.7	Wind raises dust, dry soil and loose paper Hair disarranged
5	Fresh breeze	8.0 - 10.7	17.8 - 23.9	Force of wind felt on body Drifting snow becomes airborne Limit of agreeable wind on land
6	Strong breeze	10.8 - 13.8	24.0 - 30.9	Umbrellas used with difficulty Hair blown straight Difficulty to walk steadily Wind noise on ears unpleasant Windborne snow above head height (blizzard)
7	Moderate gale	13.9 - 17.1	31.0 - 38.3	Inconvenience felt when walking
8	Fresh gale	17.2 - 20.7	38.4 - 46.3	Generally impedes progress Great difficulty with balance in gusts
9	Strong gale	20.8 - 24.4	46.4 - 54.6	People blown over by gusts

*Effective gusts

Table 2. Comparison Between Different Configuratio's for the 1% Predicted Average, Effective Gust and Peak Gust Velocities (mph)

Area	Station No.	Configuration	Average Velocity	Average Difference	Effective Gust Velocity	Effective Gust Difference	Peak Gust Velocity	Peak Gust Difference	Ave.Diff.
Sidewalks around complex	1	Existing	9.5		16.2		24.5		
		50' spacing	12.0	+2.5	18.8	+2.6	25.2	+0.7	+1.93
		60' spacing	11.4	+1.9	17.3	+1.1	24.8	+0.3	+1.10
	3	Existing	10.8		17.3		24.2		
		50' spacing	14.8	+4.0	21.5	+4.2	29.5	+5.3	+4.50
		60' spacing	14.5	+3.7	22.1	+4.8	30.5	+6.3	+4.93
	5	Existing	14.5		21.6		29.9		
		50' spacing	14.7	+0.2	22.1	+0.5	29.8	-0.1	+0.20
		60' spacing	14.5	0.0	21.7	+0.1	29.0	-0.9	-0.23
	7	Existing	18.6		27.3		36.3		
		50' spacing	16.6	-2.0	23.6	-3.7	31.4	-4.9	-3.53
		60' spacing	16.2	-2.4	23.0	-4.3	30.6	-5.7	-4.13
	9	Existing	15.0		23.8		33.3		
		50' spacing	15.4	+0.4	23.4	-0.4	31.4	-1.9	-0.63
		60' spacing	15.8	+0.8	23.6	-0.2	30.5	-2.8	-0.73
		Tree 2	13.3	-1.7	20.4	-3.4	29.7	-3.6	-2.90
		Tree 3	12.9	-2.1	20.1	-3.7	29.6	-3.7	-3.17
	11	Existing	21.7		29.2		35.8		
		50' spacing	12.9	-8.8	19.8	-9.4	28.0	-7.8	-8.67
		60' spacing	15.6	-6.1	22.6	-6.6	31.3	-4.5	-5.73
		Tree 1	9.8	-11.9	14.6	-14.6	20.5	-15.3	-13.93
		Tree 2	10.7	-11.0	15.4	-13.8	21.8	-14.0	-12.93
		Tree 3	10.6	-11.1	15.4	-13.8	21.7	-14.1	-13.00
	12	Existing	19.8		28.4		35.3		
		50' spacing	20.1	+0.3	26.1	-2.3	33.1	-2.2	-1.40
		60' spacing	21.5	+1.7	27.3	-1.1	33.8	-1.5	-0.30
		Tree 1	8.7	-11.1	13.1	-15.3	18.8	-16.5	-14.30
		Tree 2	13.4	-6.4	17.6	-10.8	22.6	-12.7	-9.97
		Tree 3	9.3	-10.5	11.8	-14.6	19.1	-16.2	-13.77

Table 2 continued

Area	Station No.	Configuration	Average Velocity	Average Difference	Effective Gust Velocity	Effective Gust Difference	Peak Gust Velocity	Peak Gust Difference	Average Difference
Sidewalks Around Complex	14	Existing	10.6		18.6		25.6		
		50' spacing	16.5	+5.9	21.7	+3.1	27.4	+1.8	+3.60
		60' spacing	20.0	+9.4	25.1	+6.5	30.1	+4.5	+6.80
		Tree 1	9.9	-0.7	14.1	-4.5	18.2	-7.4	-4.20
		Tree 2	7.5	-3.1	10.8	-7.8	14.6	-11.0	-7.30
		Tree 3	7.5	-3.1	10.7	-7.9	14.3	-11.3	-7.43
	15	Existing	14.6		19.6		24.7		
		50' spacing	17.7	+3.1	23.6	+4.0	30.3	+5.6	+4.23
		60' spacing	18.2	+3.6	24.2	+4.6	30.1	+5.4	+4.53
	17	Existing	19.8		24.2		30.0		
		50' spacing	11.8	-8.0	16.9	-7.3	23.3	-6.7	-7.33
		60' spacing	13.1	-6.7	18.7	-5.5	25.2	-4.8	-5.67
	19	Existing	16.3		23.6		29.3		
		50' spacing	10.9	-5.4	15.9	-7.7	21.9	-7.4	-6.83
		60' spacing	12.6	-3.7	17.8	-5.8	23.9	-5.4	-4.97
Walkways Inside Complex	22	50' spacing	14.1		21.0		28.4		
		60' spacing	11.2		16.9		24.3		
	24	Existing	9.1		15.2		21.0		
		50' spacing	9.1	0.0	14.7	-0.5	21.8	+0.8	+0.10
		60' spacing	8.3	-0.8	13.2	-2.0	18.6	-2.4	-1.73
	26	50' spacing	12.9		19.7		28.1		
		60' spacing	10.6		16.3		23.1		
	28	Existing	14.8		21.2		27.6		
		50' spacing	7.1	-7.7	12.3	-8.9	19.9	-7.7	-8.10
		60' spacing	6.5	-8.3	11.0	-10.2	16.8	-10.8	-9.77
	110	50' spacing	15.2		21.2		29.5		
		60' spacing	11.2		17.2		23.4		
	111	50' spacing	15.2		21.3		27.5		
		60' spacing	9.1		13.2		18.9		
Northeast Block	31	Existing	17.7		24.4		33.5		
		50' spacing	17.6	-0.1	23.9	-0.5	31.5	-2.0	-0.87
		60' spacing	18.0	+0.3	23.9	-0.5	32.6	-0.9	-0.37
	33	Existing	10.9		18.4		28.0		
		50' spacing	10.7	-0.9	17.7	-0.7	25.8	-2.2	-1.27
		60' spacing	11.2	+0.3	18.8	+0.4	26.9	-1.1	-0.13
North Block	39	Existing	13.3		21.2		30.4		
		50' spacing	14.0	+0.7	21.9	+0.7	32.9	+2.5	+1.30
		60' spacing	13.3	0.0	20.5	-0.7	28.7	-1.7	-0.80
	43	Existing	10.6		16.5		24.2		
		50' spacing	9.1	-1.5	17.8	-1.7	23.9	-0.3	-1.17
		60' spacing	9.4	-1.2	15.1	-1.4	23.1	-1.1	-1.23
Northwest Block	48	Existing	18.9		26.6		33.3		
		50' spacing	21.2	+2.3	28.7	+2.1	36.6	+3.3	+2.57
		60' spacing	18.7	-0.2	25.9	-0.7	33.5	+0.2	-0.23

Table 2 continued

Area	Station No.	Configuration	Average Velocity	Average Difference	Effective Gust Velocity	Effective Gust Difference	Peak Gust Velocity	Peak Gust Difference	Average Difference
West Block (Trinity Church) (Copley Park)	52	Existing	18.3		25.6		34.2		
		50' spacing	18.2	-0.1	25.0	-0.6	33.1	-1.1	-0.60
		60' spacing	17.8	-0.5	25.0	-0.6	33.5	-0.7	-0.60
	53	Existing	19.1		25.6		33.8		
		50' spacing	18.2	-0.9	25.4	-0.2	33.3	-0.5	-0.53
		60' spacing	17.5	-1.6	23.7	-1.9	30.5	-3.3	-2.27
	58	Tree 2	5.6		9.1		14.0		
		Tree 3	5.5		8.9		13.7		
	59	Existing	23.9		32.1		39.0		
		50' spacing	27.3	+3.4	35.2	+3.1	42.1	+3.1	+3.20
		60' spacing	24.8	+0.9	32.2	+0.1	39.1	+0.1	+0.37
		Tree 1	22.6	-1.3	29.9	-2.2	36.6	-2.4	-1.97
		Tree 2	18.3	-5.6	26.4	-5.7	33.9	-5.1	-5.47
		Tree 3	14.6	-9.3	20.4	-11.7	27.2	-11.8	-10.43
	62	Existing	26.9		33.9		39.8		
		50' spacing	27.1	+0.2	33.5	-0.4	39.0	-0.8	-0.33
		60' spacing	26.9	0.0	33.6	-0.3	38.6	-1.2	-0.50
		Tree 1	25.7	-1.2	31.8	-2.2	36.8	-3.0	-2.13
		Tree 2	27.2	+0.3	33.3	-0.6	39.4	-0.4	-0.23
		Tree 3	25.9	-1.0	32.1	-1.8	38.2	-1.6	-1.47
Southwest Block (John Hancock Tower)	66	Existing	32.9		39.7		42.2		
		50' spacing	29.9	-3.0	37.0	-2.7	43.5	+1.3	-1.47
		60' spacing	30.5	-2.4	37.4	-2.3	44.1	+1.9	-0.93
		Tree 1	28.6	-4.3	34.9	-4.8	40.9	-1.3	-3.47
		Tree 2	28.3	-4.6	34.4	-5.3	41.7	-0.5	-3.47
		Tree 3	29.0	-3.9	35.6	-4.1	42.9	+0.7	-2.43
	73	Existing	23.2		32.0		39.4		
		50' spacing	24.1	+0.9	32.5	+0.5	39.1	-0.3	+0.37
		60' spacing	24.2	+1.0	32.7	+0.7	40.0	+0.6	+0.77
		Tree 1	21.9	-1.3	29.8	-2.2	38.4	-1.0	-1.50
South Block (Old John Hancock Building)	80	Existing	25.3		31.4		37.6		
		50' spacing	24.5	-0.8	31.7	+0.3	37.6	0.0	-0.17
		60' spacing	24.8	-0.5	32.2	+0.8	37.8	+0.2	+0.17
		Tree 1	22.0	-3.3	29.1	-2.3	35.8	-1.8	-2.47
	87	Existing	20.6		27.0		34.6		
		50' spacing	19.1	-1.5	24.9	-2.1	32.3	-2.3	-1.97
		60' spacing	20.1	-0.5	25.9	-1.1	33.1	-1.5	-1.03
Southeast Block	94	Existing	14.5		20.6		27.6		
		50' spacing	17.6	+3.1	23.9	+3.3	30.9	+3.3	+3.23
		60' spacing	16.7	+2.2	23.3	+2.7	30.5	+2.9	+2.60
East Block	104	Existing	12.7		18.8		25.9		
		50' spacing	14.5	+1.8	20.8	+2.0	28.8	+2.9	+2.23
		60' spacing	15.7	+3.0	20.7	+1.9	27.1	+1.2	+2.03

Table 3. Melbourne's Category for Each Station - Annual and Seasonal

Station	Configuration	Annual	Winter	Spring	Summer	Fall
1	Existing	4	4	4	5	4
	50' spacing	4	4	4	5	4
	60' spacing	4	4	4	5	4
3	Existing	4	4	4	5	4
	50' spacing	3	3	3	4	3
	60' spacing	3	3	3	4	3
5	Existing	3	3	3	5	3
	50' spacing	3	3	3	4	3
	60' spacing	3	3	3	4	3
7	Existing	2	2	2	3	3
	50' spacing	3	3	3	3	3
	60' spacing	3	3	3	3	3
9	Existing	3	3	3	3	3
	50' spacing	3	3	3	4	3
	60' spacing	3	3	3	3	3
	Tree 2	4	3	3	4	4
	Tree 3	4	3	3	4	4
11	Existing	2	2*	2*	3	2
	50' spacing	4	4	4	4	4
	60' spacing	3	3	3	4	3
	Tree 1	5	5	5	5	5
	Tree 2	5	5	5	5	5
	Tree 3	5	5	5	5	5
12	Existing	2	2	2	3	2
	50' spacing	2	2*	2	3	3
	60' spacing	2	2*	2*	3	2
	Tree 1	5	5	5	5	5
	Tree 2	4	4	3	5	4
	Tree 3	5	5	5	5	5
14	Existing	4	4	4	5	4
	50' spacing	3	3	3	4	4
	60' spacing	2	2*	2	3	3
	Tree 1	5	5	5	5	5
	Tree 2	5	5	5	5	5
	Tree 3	5	5	5	5	5
15	Existing	3	4	3	4	4
	50' spacing	3	2	3	4	3
	60' spacing	3	2	3	4	3
17	Existing	2	2	2	3	3
	50' spacing	5	4	4	5	5
	60' spacing	4	4	4	5	4
19	Existing	3	3	3	3	3
	50' spacing	5	5	5	5	5
	60' spacing	4	4	4	5	5
22	50' spacing	4	3	3	5	4
	60' spacing	4	4	4	5	5
24	Existing	5	5	5	5	5
	50' spacing	5	4	5	5	5
	60' spacing	5	5	5	5	5
26	50' spacing	4	3	4	5	4
	60' spacing	5	4	5	5	5
28	Existing	4	3	3	5	4
	50' spacing	5	5	5	5	5
	60' spacing	5	5	5	5	5
110	50' spacing	3	3	3	5	4
	60' spacing	4	4	4	5	5
111	50' spacing	3	3	3	5	4
	60' spacing	5	5	5	5	5
31	Existing	3	2	3	4	3
	50' spacing	3	2	3	4	3
	60' spacing	3	2	3	4	3
33	Existing	4	3	4	5	4
	50' spacing	4	4	4	5	4
	60' spacing	4	4	4	5	4
39	Existing	3	3	3	4	3
	50' spacing	3	3	3	4	3
	60' spacing	4	4	3	4	3
43	Existing	4	4	4	5	4
	50' spacing	4	4	4	5	5
	60' spacing	5	4	4	5	5
48	Existing	3	3	2	3	3
	50' spacing	2	2	2*	2	2
	60' spacing	3	3	2	3	3
52	Existing	3	2	3	4	3
	50' spacing	3	2	3	4	3
	60' spacing	3	2	3	4	3
53	Existing	2	2	2	3	3
	50' spacing	3	3	2	3	3
	60' spacing	3	3	3	3	3
58	Tree 2	5	5	5	5	5
	Tree 3	5	5	5	5	5
59	Existing	2*	2*	2*	2	2*
	50' spacing	1*	2*	1*	2	1*
	60' spacing	2*	2*	1*	3	2*
	Tree 1	2*	2*	2*	3	2*
	Tree 2	3	2	2	4	2
	Tree 3	4	3	3	4	4
62	Existing	2*	1*	1*	2*	1*
	50' spacing	1*	1*	1*	2*	1*
	60' spacing	2*	1*	1*	2	1*
	Tree 1	2*	2*	1*	2	2*
	Tree 2	1*	1*	1*	2*	1*
	Tree 3	2*	2*	1*	2*	2*
66	Existing	1*	1*	1*	2*	1*
	50' spacing	1*	1*	1*	2*	1*
	60' spacing	1*	1*	1*	2*	1*
	Tree 1	1*	1*	1*	2	1*
	Tree 2	1*	1*	1*	2	1*
	Tree 3	1*	1*	1*	2	1*
73	Existing	2*	2*	2*	3	2*
	50' spacing	2*	2*	2*	2	2*
	60' spacing	2*	2*	2*	2	2*
	Tree 1	2	2*	2*	3	2
80	Existing	2*	2*	1*	2	2*
	50' spacing	2*	2*	2*	2	2*
	60' spacing	2*	2*	2*	2	2*
	Tree 1	2*	2	2*	3	2*
87	Existing	2	2*	2	3	2
	50' spacing	2	2	2	3	2
	60' spacing	2	2	2	3	2
94	Existing	4	3	3	4	4
	50' spacing	3	2	3	4	3
	60' spacing	3	3	3	4	3
104	Existing	4	4	4	5	4
	50' spacing	4	3	4	4	4
	60' spacing	3	3	3	4	4

* Exceeds BRA Criteria

APPENDIX I

DESCRIPTION OF THE EXPERIMENTAL EQUIPMENT

The Wright Brothers Memorial Wind Tunnel is a closed return wind tunnel with a 7.5 by 10.0 foot elliptical test section approximately 15 feet long (see Figure 1). Wind speeds up to 185 mph are currently available.

For non-aeronautical tests such as represented by this study, a special floor is installed at a height of one foot above the regular floor of the wind tunnel, and extends from 2 feet into the contraction section to 4 feet into the diffuser. This "ground board" provides a flat plane on which to develop a simulated earth's boundary layer. An 8 foot diameter turntable is mounted flush with the ground board in order to rotate the model so as to simulate the wind coming from any direction. The center of the turntable is 15 feet from the leading edge of the ground board (see Figure 2).

A scaled earth's boundary layer was developed in the wind tunnel using spires installed near the leading edge of the ground board, and cubical roughness blocks were distributed between the spires and the turntable along the direction of flow as shown in Figure 2.

A 1/600 scale model of the New England complex and its vicinity was placed on the turntable in the wind tunnel in the simulated earth's boundary layer flow. Two hot wires were used at a time for this test. Figure 3 contains a schematic of the wires used. When set on the tunnel floor the hot wire went from about 0.05 to 0.16 inches (2.5 to 8.0 ft. full scale). The sensitivity of these hot wires to wind direction is given in Figure 3. The error shown is less than 5% for misalignments with respect to the wind direction of up to 40 degrees. Even so, before placing the hot wire at a station, the wind direction was checked by placing a tuft attached to the end of a stick at the station. Each hot wire probe was attached to the end of a 15 inch long rod weighted at its top. The upper end just below the weight passed through a ring about one foot above the model. The position of the ring in the horizontal plane could be adjusted to be directly over any station.

Two Flow Corporation 900-1 controllers and two 900-3 type linearizers were used to control the hot wires and linearize the output from them.

APPENDIX II

CALIBRATION OF THE SIMULATED EARTH'S BOUNDARY LAYER

A2.1 INTRODUCTION

Proper wind tunnel simulation of the earth's atmospheric boundary layer requires careful consideration of the significant scaling relationships. The parameters in wind tunnel-to-full scale simulation are (1) the gradient of the average velocity, (2) longitudinal root-mean-squared (RMS) turbulence fluctuation about the average, and (3) the power spectrum of the longitudinal velocity component. Scaling on the basis of these parameters represents state-of-the-art methods in wind tunnel testing of ground structures. Each of these parameters and the similarity relation for sampling times are discussed in some detail below.

A2.2 VELOCITY GRADIENT SIMULATION

The gradient of the average velocity, or variation of the average velocity with height, can be simulated readily (Epstein [9]). Davenport [6] states that while other more sophisticated approximations exist to the vertical velocity gradient of the earth's boundary layer, the overall accuracy is not significantly better than the simple approximation:

$$U/Ug = (h/hg)^{\alpha}$$

where:

U = average wind velocity at height h
Ug = average wind velocity at gradient height hg
α = power law constant, typically varies from 0.14 to 0.45

Davenport [4,6] shows that hg and α vary approximately with the terrain, as given in the table below. These parameters and their appropriate terrain are depicted in Figure 4.

GRADIENT HEIGHT AND EXPONENT AS FUNCTION OF TERRAIN

TERRAIN	GRADIENT HEIGHT	EXPONENT
URBAN	1700	0.40
SUBURBAN	1300	0.28
OPEN	900	0.16

The boundary layer used for these tests had values equivalent to α = 0.225 and hg = 1800 feet full scale. The values found for and gradient height were considered reasonable for the area where the NEL complex is located. It must be remembered that the values for α and hg presented in the table above are guidelines and are representative of the velocity gradients that Davenport suggests from his surveys of experimental results. These values cannot be expected to agree exactly with any site. For a review of the variations that have been found by other authors at other sites, see the article by Counihan [3].

The gradient height modeled in the wind tunnel for α = 0.225 was 1800 feet, which is 680 feet higher than the value of 1120 ft. interpolated from the table above. Figure A1 depicts the average modeled gradient measured at the center of the turntable. The ground wind data given in Tables A3.1.1 - A3.4.8 is divided by the actual gradient velocity in the wind tunnel. All data from the tests was corrected to the correct gradient height as it was used with the Boston Weibull constants to compute the 100 hour return period velocities.

A2.3 LONGITUDINAL TURBULENCE INTENSITY

Longitudinal turbulence intensity is a measure of the root-mean-squared (RMS) velocity variation about the average velocity (i.e. a measure of the energy in the gusting part of the flow). In Figure A2 the ratio of longitudinal turbulence intensity to gradient wind velocity is plotted versus height in wind tunnel and compared with actual wind data. The wind tunnel values are compared with strong wind data from Brookhaven, NY, USA, and Sale, Australia, as presented in Campbell and Standen [1].

Brookhaven is considered typical of suburban areas and so Campbell and Standen [1] have assumed the exponent α = 0.28 and height hg = 1300 feet. Sale, Australia is considered to represent open terrain and has been assigned α = 0.16 and hg = 900 feet. These values appear to have been selected directly from Davenport's results, which were given above in section 3.2. In a later publication, Counihan [3] presents values of α = 0.21 to 0.33 for Brookhaven and α = 0.16 to 0.176 for Sale. These have been compiled from various authors published since 1955. The scatter in the values is probably reasonable, since it is unlikely that any of the data was taken in truly adiabatic conditions. Thus a comparison of controlled wind tunnel turbulence intensity to atmospheric conditions must be interpreted for general, not exact, agreement.

For the NEL site, the turbulence intensity in the wind

tunnel falls within the scatter of Brookhaven and Sale. The wind tunnel turbulence data shown were taken with a gradient wind speed of about 30 mph.

A2.4 POWER SPECTRAL DENSITY

The power spectral density is a measure of the distribution of the kinetic energy of the velocity fluctuations over the entire range of fluctuating frequencies encountered. The power spectrum of the longitudinal velocity component of the simulated flow described above was obtained with the aid of the WBWT PDP 11-23 computer. The wind velocity was sampled at 256 times per second for four seconds, and the data was passed through a fast Fourier transform to calculate the values of the power spectrum. Data was taken at 12 inches above the wind tunnel floor, corresponding to 600 feet full scale. The power spectrum shown in Figure A3 is the average of 32 spectra. The shape of the spectrum shown is in reasonable agreement with the empirical strong wind spectrum proposed by Davenport and Isyumov [6] and the more theoretical spectrum of Von Karman (Epstein [8]). Davenport's spectrum is defined by:

$$\frac{n\,S(n)}{\sigma^2} = \frac{2}{3}\,\frac{X^2}{(1+X^2)^{4/3}}$$

Von Karman's spectrum is defined by:

$$\frac{n\,S(n)}{\sigma^2} = \frac{2}{\pi}\,\frac{X_v}{(1+X_v^2)^{5/6}}$$

where:

- X = nL/U33
- X_v = 2πnlx/Ug
- S(n) = power spectral density function
- N, n = frequency - full scale,model
- U33 = average wind velocity at 33 feet above ground surface
- L = 3000 feet full scale
- lx = Integral scale, 400 feet full scale
- σ = RMS of flunctuating wind velocity

According to Davenport [6], the power spectral density function is independent of height for much of the boundary layer height. Wind velocity is a function of height, h. To convert N/U33 full scale to n/U1 in the tunnel (U1 is the average wind velocity at 1 foot above the floor of the tunnel), the following relationship is used:

$$\frac{n}{U_1} = m\left(\frac{33}{m}\right)^{\alpha}\frac{N}{U_{33}}$$

where m is the reciprocal of the scale factor and α is the velocity gradient power law constant. In this test, m = 600, and α= 0.225.

Note that proper matching of the power spectrum assures that the sizes of the gusts in the wind tunnel are appropriately scaled and distributed over the range of gust sizes.

A2.5 "SIMILARITY RELATION" FOR SAMPLING TIMES

A2.5.1 Introduction

In order to use the wind tunnel results with the predicted return period winds from the wind climate analysis, it was necessary to establish for the particular model scale what time span in the wind tunnel constitutes the equivalent of one hour full scale. A full scale time span of one hour was chosen because of its location in the meteorological spectral gap, as reported by Van der Hoven [23].

For an average or RMS wind velocity, the one hour time span was not critical. The requirement is only a sufficient time to obtain the average and the RMS variation about the average. When measuring peak winds, an increased sampling time results in increased peaks, due to the random nature of the peaks. The increases in the peaks display diminishing values as the sampling time increases without bound. Thus it is important when peaks are measured that the time relationship between model and full scale be appropriately established.

The "similarity parameter" (nondimensional time period) used for establishing the time relationship is :

$$TU/D = tu/d$$

where:

T, t = period of sampling time,
U, u = average wind speed during sample,
D, d = characteristic dimension of model or building, and
Capital and lower case are for full scale and model respectively.

This "similarity parameter" should be held constant between a wind tunnel model and a full scale situation.

A2.5.2 Ground Winds Sampling Times

In the hot wire study the gradient wind was kept at 30 mph.

The 100 hour return period gradient average hourly wind speed in Boston is 44 mph. The ratio of these two speeds, while not correct for any given pedestrian level wind speed measured, will be about correct on the average. An estimate of the required sampling time for the model was found from the previously mentioned nondimensional time period.

$D/d = 600$, $u = 30$ mph, $U = 44$ mph, $T = 3600$ sec, which leads to $t = 8.8$ sec

For the hot wire study a sampling time of 8.8 seconds was used. Murakami et al [17] and others [13] have shown that only gusts lasting longer than two to three seconds seriously affect people. Thus it is important to only measure those gusts lasting longer than the equivalent of two seconds full scale. Using the same reasoning as above it was found that only gusts lasting longer than 0.006 seconds in the wind tunnel should be measured. Thus a 0.005 second resistance-capacitive filter was used with the hot wires.

APPENDIX III

REDUCTION OF DATA

A3.1 WIND TUNNEL HOT WIRE DATA

Two hot wires were used at a time to measure the wind velocity at each of two stations. The data from each hot wire was sampled at 930 hz to obtain 512 readings of the voltage from each hot wire. Calibration data obtained just prior to each run was then applied to each reading and the average (Vav), root mean square variation about the average (Vrms), and the peak (Vpk) velocities found for each set of readings. Each set of 512 readings from a hot wire was one group of readings. A total of 16 groups was read for each station at each direction. The 16 average, and rms velocities, were then combined to find the overall average (Vav) and rms (Vrms) for the entire 8.8 second sample.

A Type I extreme value analysis [12] was performed on the 16 peaks (one from each the 16 groups of data) from each station for each direction to obtain a better estimate of the expected peak for the 8.8 second sample than the single measured peak (see references [8] and [12]). It is this peak velocity which is used in the tables and for all calculations.

All data was then normalized by dividing by the average gradient velocity during the 16 samples to obtain a value for Vav/Vgr, Vrms/Vgr, and Vpk/Vgr for each station for each wind direction (see Tables A3.1.1 - A3.4.8). The values of Vav/Vgr, Vrms/Vgr and Vpk/Vgr were then used in conjunction with a statistical description of the Boston wind climate to calculate how often a given average velocity, effective gust, or peak gust will occur at any chosen station. This procedure has been carried out for all the stations for both annual and seasonal time periods.

A3.2 THE WIND CLIMATE USED

Surface wind data was obtained for Logan Airport for the years 1945 to 1965 from the National Climatic Center in Asheville, N.C. The data consists of 24 one-minute observations per day taken at hourly intervals and includes over 176000 observatioms. The data was sorted by 16 directions (NNE, NE, ..., S, SSW, ..., NNW ,N) and the data as a whole as well as by direction fitted with Weibull probability distributions [12]. The Weibull probability distribution has the form:

$$P(u>u_p) = A_n e^{-\left(\frac{u_p}{u_n}\right)^{K_n}} \qquad \text{(eq 3A.1)}$$

where:

P(U>Up) is the probability of U exceeding Up.

An is the total probability of the wind coming from direction n. Direction n is the included angle between one half way towards direction n-1 and one half way towards direction n+1.

Un is a scaling velocity determined from the fit of the wind climate data to the Weibull approximation.

Kn is an exponent determined from the fit of the the Weibull approximation to the wind climate data.

The values of An, Un, and Kn were obtained for each of the 16 compass directions used for an annual time period as well as for each season. The values obtained are given in Tables A1.1 - A1.5. The 17th values in the tables are for all winds. The values of Un given in the tables have been adjusted so that Up is the hourly average at gradient height in order that the Weibull fit may be applied directly to the wind tunnel data. In carrying out the above correction to Un, it was assumed that the data as taken at Logan Airport were equivalent to one hour averages. The Un was corrected to gradient height by using an average height for the data of 58 feet and assuming a power law boundary layer at the airport with a gradient height of 900 feet and an α=0.16.

In making the Weibull fits to the actual data from Logan it was found that it was not possible to obtain a good fit over the entire range of velocities. Since the Weibull fit obtained was to be used to calculate the velocities that occurred 1% of the time, the best fit from about 2% to 0.1% was obtained for each season and direction. Further it was found that if one also obtained the annual Weibull constants in this way from the annual data, the sum of the probabilities from the four seasons calculated from the Weibull coefficients did not add up to the annual ones for each direction. Thus the seasonal and annual probabilities calculated from the Weibull coefficients obtained this way were not consistent.

To overcome that difficulty the probabilities from each season were calculated from the derived Weibull coefficients and added up to obtain the annual probabilities. These calculated probabilities were then used to obtain the annual Weibull coefficients for each direction. Finally the calculated probabilities calculated from this fit to the sum of the seasonal probabilities were compared with the results from the fit to the annual data and the annual data itself. The resulting comparison showed that the fit derived from the sum of the seasonal probabilities for each direction was nearly as good as that derived directly from the annual data. Thus the coefficients

derived from the sum of the annual data has been used in this report and is what is given in Tables A1.1 - A1.5.

A3.3 CALCULATING THE PREDICTED ONE PERCENT RETURN PERIOD VELOCITIES FROM THE HOT WIRE DATA

The average, rms, and peak velocity ratios in Tables A3.1.1 - A3.4.8 and the Weibull coefficients in Tables A1.1 - A1.5 have been used to calculate the average, effective gust, and peak gust velocities that will be exceeded during one hour once in 100 hours at each station for annual as well as seasonal time periods. To accomplish that calculation an iteration procedure was used. First one assumes a value for the 1% average, effective gust, or peak gust velocity. Then for each of the 16 directions, one divides that velocity by Vav/Vgr, Veg/Vgr, or Vpk/Vgr to obtain Vgr (Veg=Vav+1.5*Vrms). Then setting Up=Vgr in the appropriate Weibull equation for that direction, one can calculate the probability of the assumed velocity occurring for each direction. The sum of the probabilities from all directions is the total probability of that assumed velocity occurring. The assumed velocity (average, effective gust, or peak gust) is iterated until the total probability is 1%. The results of those calculations are given in Table A2.1.1 - A2.4.5.

APPENDIX IV

CRITERIA FOR PEDESTRIAN LEVEL WINDS

Many authors have attempted to define criteria for pedestrian level winds. The task is made especially difficult because it is complex and the results are subjective. Further to be meaningful the result must be expressed in probabilistic form.

One of the first attempts to define a criteria for wind was made by Admiral Beaufort in 1806. It was an absolute criteria designed to allow a sailor to tell the difference between light breezes, gales, etc. It is still in use today. Penwarden [18] has reinterpreted the Beaufort scale for pedestrian level winds (see Table 1). However, one must be careful using Table 1, because while the original Beaufort scale was apparently based on average winds, the values given by Penwarden are for some sort of average gust similar to the effective gust defined in Appendix III.

What is significant about the Beaufort scale as given in Table 1 is that at or above Beaufort 9 (47-55 mph) a number of authors [13, 16, 17] have noted people have great difficulty in walking and a number of people have been hurt. Thus it is now generally agreed [2, 5, 10, 13, 14, 15, 16, 17, 18, 19, 20] that wind speeds of Beaufort 9 or greater are dangerous and unacceptable.

Another aspect of the problem is defining what kinds of winds are annoying, and/or affect a person. The two most significant works in this area are by Hunt et al [13] and Murakami et al [17]. Both conclude that gusts shorter than 2-3 seconds do not seriously affect people. It is for that reason a 0.005 second low pass filter was used in the hot wire tests. Such a filter eliminates all gusts shorter than the equivalent of 2-3 seconds full scale.

Both of the above are absolute criteria. Clearly in a major storm it would not be surprising to encounter Beaufort 9. On the other hand it is reasonable not to expect Beaufort 9 very often. To answer the question how often it is acceptable leads us to using a probabilistic approach.

In 1978 Melbourne [15] reviewed the literature to find a comprehensive probabilistic criteria for hourly average pedestrian level winds that would be applicable to different types of pedestrian activities as well as cover the safety aspects. He found and included data from Canada [5], England [13,14,18], and Australia [16]. When assembled on a single plot, all the criteria proved to be similar. The results of that study

are summarized in Figure 5. The results of Radovsky and Durgin [21] and Cohen et al [2] from the USA have also been included. The vertical scale is the average hourly velocity in miles per hour and the horizontal scale is the probability based on hours of that average velocity occurring. Five criteria are given and labeled. They are "unacceptable and dangerous," "uncomfortable for walking," "acceptable for walking," "acceptable for short periods of standing," and "acceptable for long periods of standing or sitting." The estimates of occurrence in weeks, months, and years are due to Davenport [5] and allow for the fact that several occurrences may occur during one storm. Melbourne's criteria for hourly average velocities have been in use at WBWT for about six years.

Originally Melbourne set up his criteria based on the peak two second gust occurring once in 1000 hours, or 3-4 times during one storm each year occurring during daylight hours. He chose to use Beaufort 9 (23 m/s (51 mph)) for the dangerous unacceptable peak gust at $P(U>Up)=0.001$ because, as noted above, it is generally accepted that a gust of that strength is likely to knock a person down. To obtain the fit with the average data from other investigators shown in Figure 5, he divided his peak velocities by 1.5.

Pedestrian level winds tend to be unsteady, and thus when measuring them one usually determines the average, the root-mean-square variation about the average (rms), and the peak velocity. A problem arises in how to define what is sensed as too windy, because sometimes it is the average, sometimes the rms, and sometimes the peak gust or a combination that makes a place seem windy. To overcome this difficulty a number of authors have defined an effective gust equal to the average plus a constant (g) times the rms. Values of the constant g from 1.0 to 3.5 have been proposed, 1.5-1.75 being the most common. The guideline maximum effective gust velocity of 31 mph used by the Boston Redevelopment Authority is apparently based on using a value of 1.5 [2, 11, 20].

The basis for the use of the constant g is that, if the distribution of gusts over an hour were Gaussian, the effective gust then would have a fixed probability of occurring in that hour. Unfortunately the assumption that the distribution of gusts is Gaussian, while true on the average, is not true for individual stations and wind directions. If it were, the gust factors listed in Tables A3.1.1 - A3.4.8 would be constant, and not vary from 2.2 to 7.5 as they do.

To obtain a probabilistic description of the pedestrian level wind at any station the appropriate velocity must be combined with an appropriate statistical description of the wind climate in the manner described in Appendix III. Melbourne, in his report and experience at the WBWT, indicates that, on the average, the predicted peak two second gust velocities found as

indicated above are two times the predicted hourly average velocities. Further if one uses g=1.50 the predicted effective gust velocities will be 1.43 times the predicted average velocities. Thus one can apply Melbourne's criteria to all three types of velocities. This has been done and the results are given in graphic form in Figures 7, 8, and 9. When the criteria as given in Figures 7, 8, and 9 are applied to the one percent average, effective gust, and peak gust velocities calculated in this report the criteria can be stated as follows:

MELBOURNE'S CRITERIA FOR AVERAGE, EFFECTIVE GUST, AND PEAK GUST VELOCITIES

CATEGORY	VELOCITY (mph) HOURLY AVERAGE	EFFECTIVE GUST	PEAK GUST
1 UNACCEPTABLE-DANGEROUS	$27 \le U_{av}$	$39 \le U_{ep}$	$55 \le U_{pk}$
2 UNCOMFORTABLE FOR WALKING	$19 \le U_{av} < 27$	$27 \le U_{ep} < 39$	$37 \le U_{pk} < 55$
3 ACCEPTABLE FOR WALKING	$15 \le U_{av} < 19$	$21 \le U_{ep} < 27$	$30 \le U_{pk} < 37$
4 STATIONARY SHORT EXPOSURE	$12 \le U_{av} < 15$	$16 \le U_{ep} < 21$	$23 \le U_{pk} < 30$
5 STATIONARY LONG EXPOSURE	$U_{av} < 12$	$U_{ep} < 16$	$U_{pk} < 23$

The dotted lines in Figures 7, 8, and 9 show the estimated conditions at 4.5 feet at Logan Airport in Boston for the three velocities. The BRA effective gust guideline velocity of 31 mph 1% of the time has been converted to apply to the average and peak velocities using the same relationships as used above to convert Melbourne's criteria. The result is shown in each figure (star in a circle).

In this report, only the average, effective gust, and peak gust that occur once in 100 hours will be used. However, each value listed really defines a complete curve like those in Figures 7, 8, and 9 passing through that point ($P(U>U_p)=0.01$).

Finally, in evaluating the stations examined in the report, it has been assumed that the category into which a station falls is the highest of the above three possibilities. In general this is a conservative approach since stations tend to fall into higher categories than when only one criterion was used. In this way, windiness due to average, rms, and peak winds can be accounted for, but the particular definition for the effective gust may not be the optimum choice.

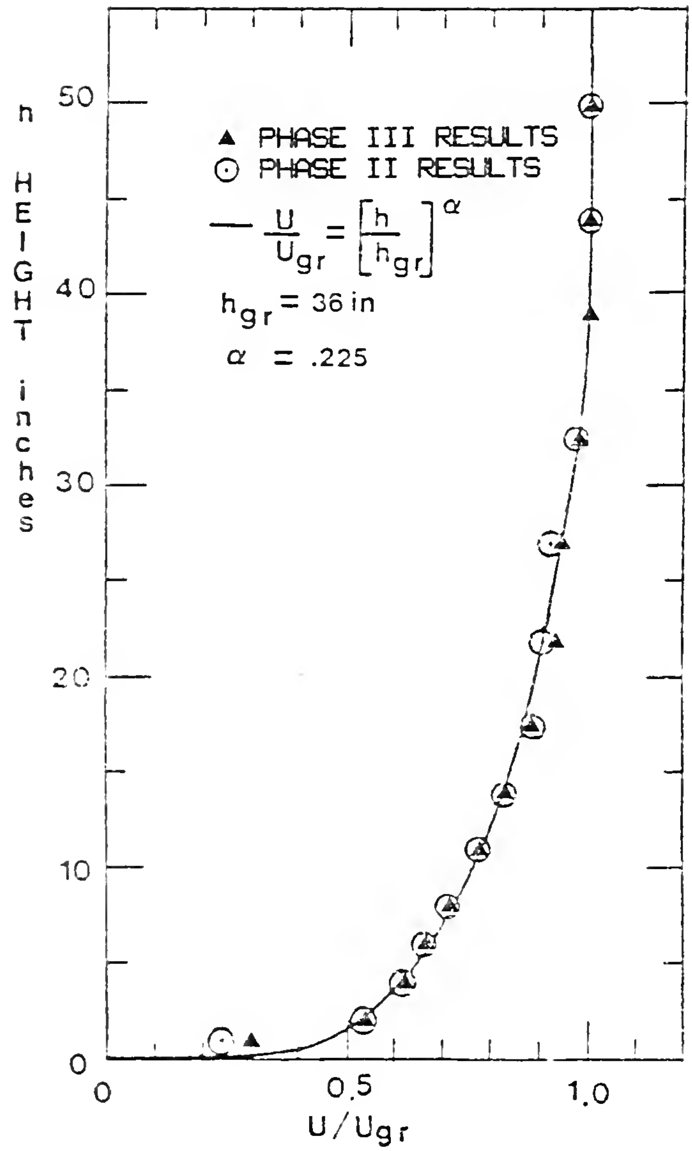


Figure A1. Variation of average velocity with height

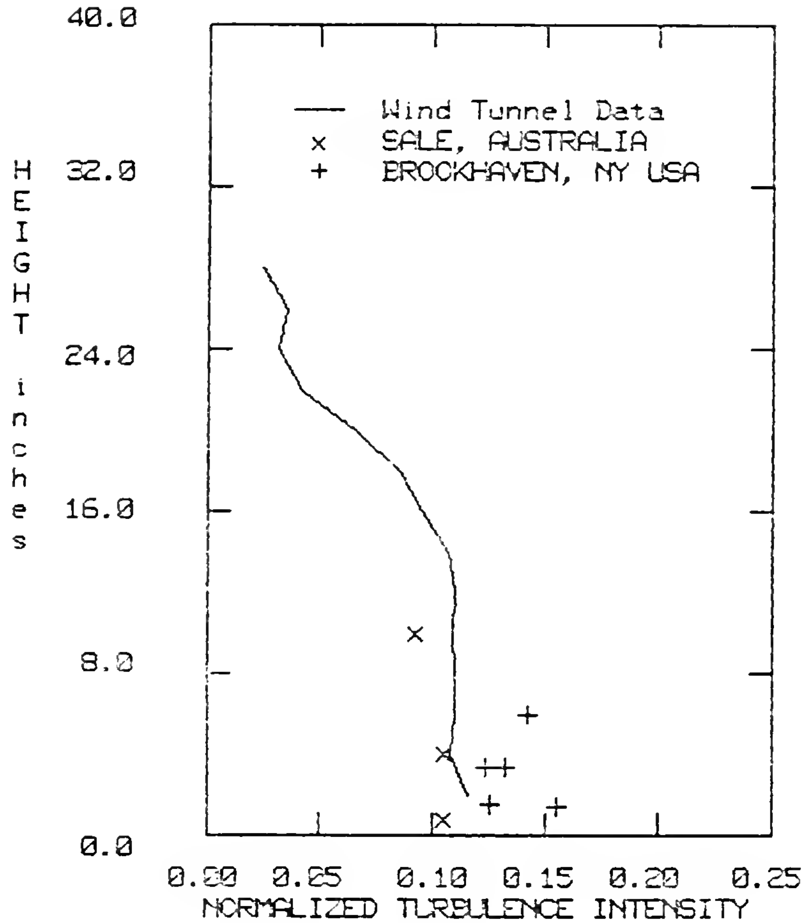


Figure A2. Normalized turbulence intensity as a function of height-tunnel center line

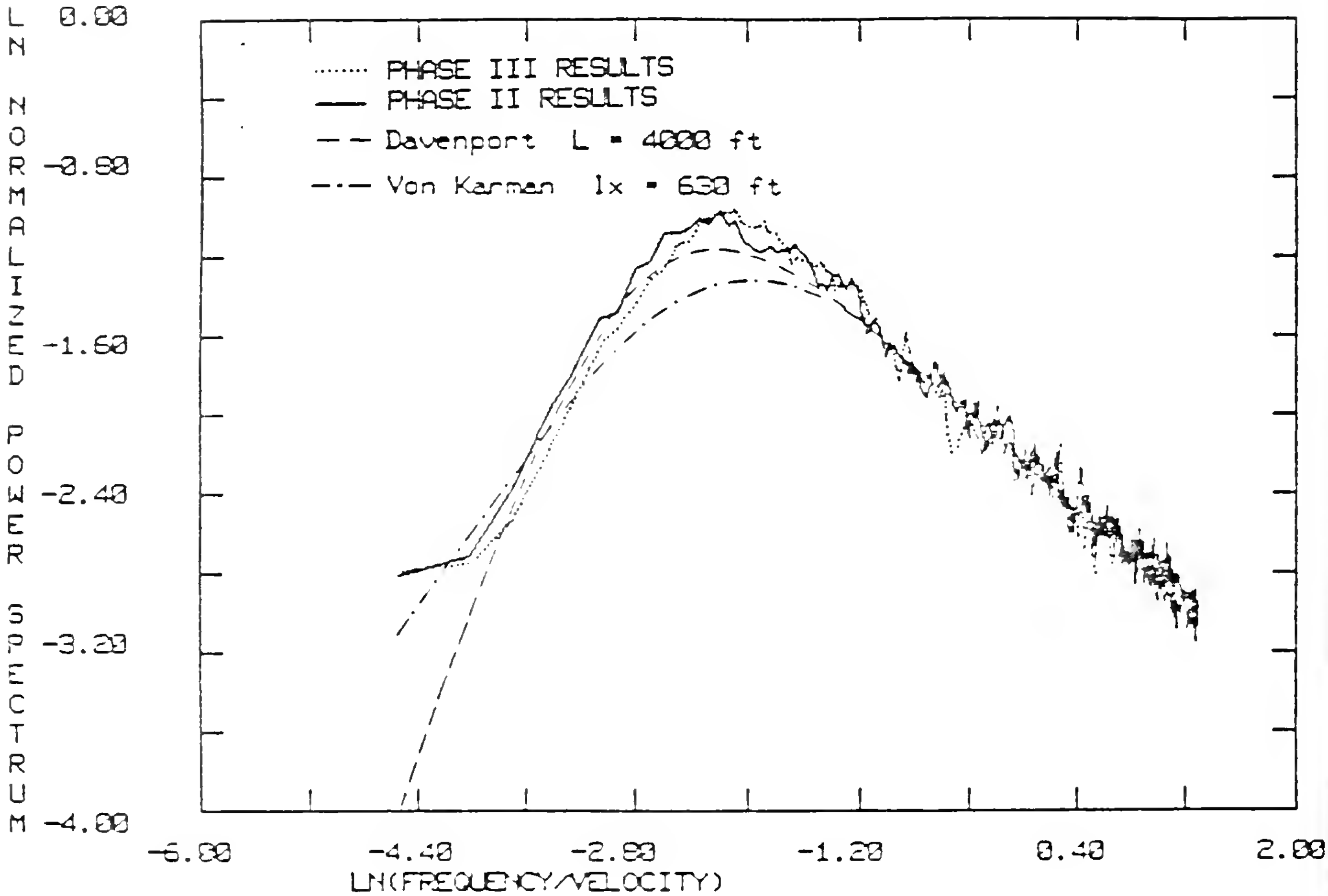


Figure A3. Comparison of wind tunnel data to boundary layer power spectrum theories

****

Table A1.1

WEIBULL CONSTANTS FOR BOSTON, ANNUAL.
CORRECTED DATA FROM LOGAN AIRPORT(1945-1965).

****

	DIRECTION	An	Kn	Un(mph)
1	NNE	.0385	1.76	20.97
2	NE	.0410	1.76	24.04
3	ENE	.0404	1.72	22.19
4	E	.0443	1.74	20.15
5	ESE	.0469	2.26	19.56
6	SE	.0379	2.47	17.30
7	SSE	.0213	2.14	16.26
8	S	.0447	2.04	18.94
9	SSW	.0750	2.02	21.69
10	SW	.1038	2.35	21.79
11	WSW	.0730	2.29	20.87
12	W	.0815	2.22	22.87
13	WNW	.1149	2.21	24.18
14	NW	.1017	2.34	25.08
15	NNW	.0717	2.48	21.87
16	N	.0475	1.99	19.37
17	ALL	1.000	2.05	22.10

****
****

Table A1.2

WEIBULL CONSTANTS FOR BOSTON, WINTER.

CORRECTED DATA FROM LOGAN AIRPORT(1945-1965).

****
****

	DIRECTION	An	Kn	Un(mph)
1	NNE	.0363	1.72	21.12
2	NE	.0289	1.43	24.08
3	ENE	.0226	1.60	26.44
4	E	.0221	1.56	22.99
5	ESE	.0208	1.49	18.44
6	SE	.0219	1.96	18.15
7	SSE	.0259	1.78	17.51
8	S	.0373	1.78	18.31
9	SSW	.0498	2.06	22.33
10	SW	.0855	2.46	23.58
11	WSW	.0780	2.69	23.33
12	W	.0996	2.66	26.08
13	WNW	.1613	2.36	27.01
14	NW	.1444	2.42	27.27
15	NNW	.1004	2.66	24.37
16	N	.0652	2.41	22.49
17	ALL	1.000	2.32	24.94

****
****

Table A1.3

WEIBULL CONSTANTS FOR BOSTON, SPRING.
CORRECTED DATA FROM LOGAN AIRPORT(1945-1965).

****
****

	DIRECTION	An	Kn	Un(mph)
1	NNE	.0404	1.99	22.78
2	NE	.0516	2.03	26.70
3	ENE	.0566	1.82	24.10
4	E	.0586	2.00	22.08
5	ESE	.0609	2.53	22.04
6	SE	.0436	2.48	19.22
7	SSE	.0317	2.07	16.92
8	S	.0459	2.15	20.80
9	SSW	.0756	2.17	24.40
10	SW	.0893	2.40	23.19
11	WSW	.0570	2.20	22.40
12	W	.0730	2.34	25.78
13	WNW	.1047	2.47	26.49
14	NW	.1004	2.61	27.16
15	NNW	.0700	2.82	24.74
16	N	.0407	1.86	20.51
17	ALL	1.000	2.13	23.63

****
****
Table A1.4
WEIBULL CONSTANTS FOR BOSTON, SUMMER.
CORRECTED DATA FROM LOGAN AIRPORT(1945-1965).

****
****

	DIRECTION	An	Kn	Un(mph)
1	NNE	.0304	1.69	18.10
2	NE	.0384	2.36	19.80
3	ENE	.0423	2.21	18.24
4	E	.0547	3.10	18.76
5	ESE	.0641	3.13	18.55
6	SE	.0498	2.78	17.15
7	SSE	.0364	2.76	14.53
8	S	.0521	2.16	18.03
9	SSW	.1009	2.67	21.53
10	SW	.1448	2.49	20.17
11	WSW	.0856	2.41	18.46
12	W	.0778	2.20	18.74
13	WNW	.0876	2.13	19.26
14	NW	.0614	2.42	21.17
15	NNW	.0417	2.29	18.96
16	N	.0320	2.24	17.56
17	ALL	1.000	2.19	18.71

****
****
Table A1.5
WEIBULL CONSTANTS FOR BOSTON, FALL.
CORRECTED DATA FROM LOGAN AIRPORT(1945-1965).

****
****

	DIRECTION	An	Kn	Un(mph)
1	NNE	.0469	1.71	21.26
2	NE	.0450	1.68	23.79
3	ENE	.0402	1.92	22.88
4	E	.0419	1.52	20.03
5	ESE	.0419	2.56	18.94
6	SE	.0362	2.51	16.81
7	SSE	.0311	2.57	16.60
8	S	.0435	2.22	17.83
9	SSW	.0738	1.55	18.08
10	SW	.1194	2.20	21.21
11	WSW	.0715	2.27	20.03
12	W	.0755	2.16	20.26
13	WNW	.1060	2.20	21.74
14	NW	.1004	2.23	22.12
15	NNW	.0748	2.29	21.26
16	N	.0519	2.07	18.56
17	ALL	1.000	1.80	19.89

Table A2.1.1

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
90 FOOT SEPARATION --- ANNUAL PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEA[K] VELOCITY
1	80	24.8	32.2	37.8
2	73	24.2	32.7	40.0
3	68	30.5	37.4	44.1
4	62	26.9	33.6	38.6
5	59	24.8	32.2	39.1
6	12	21.5	27.3	33.8
7	11	15.6	22.6	31.3
8	110	11.2	17.2	23.4
9	28	6.5	11.0	16.8
10	26	10.6	16.3	23.1
11	7	16.2	23.0	30.6
12	9	15.8	23.6	30.5
13	48	18.7	25.9	33.5
14	53	17.5	23.7	30.5
15	52	17.8	25.0	33.5
16	43	9.4	15.1	23.1
17	39	13.3	20.5	28.7
18	5	14.5	21.7	29.0
19	3	14.5	22.1	30.5
20	1	11.4	17.3	24.8
21	31	18.0	23.9	32.6
22	33	11.2	18.8	26.9
23	22	11.2	16.9	24.3
24	24	8.3	13.2	18.6
25	111	9.1	13.2	18.9
26	19	12.6	17.8	23.9
27	14	20.0	25.1	30.1
28	15	18.2	24.2	30.1
29	17	13.1	18.7	25.2
30	94	16.7	23.3	30.5
31	87	20.1	25.9	33.1
32	104	15.7	20.7	27.1

AVERAGE OF 1% AVERAGE VELOCITY = 16.25
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 22.57
AVERAGE OF 1% PEAK VELOCITY = 29.50

Table A2.1.2

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

[illegible] --- WINTER PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	80	26.0	33.8	40.1
2	73	24.9	33.8	41.3
3	66	22.5	29.9	47.1
4	62	27.8	34.9	40.3
5	59	25.4	33.3	40.9
6	12	24.2	30.4	37.1
7	11	16.2	23.5	32.2
8	110	12.7	18.9	25.4
9	28	6.5	11.1	17.3
10	36	11.9	17.9	25.1
11	7	16.0	23.3	31.6
12	9	15.9	23.8	31.4
13	48	18.2	25.7	34.1
14	53	17.6	24.1	31.5
15	52	19.8	27.8	37.0
16	43	9.6	15.4	24.4
17	39	13.7	21.0	29.4
18	5	14.8	22.0	29.7
19	3	15.5	23.7	32.8
20	1	11.8	18.0	25.8
21	31	20.3	26.8	36.6
22	33	12.2	20.7	29.7
23	22	12.7	19.1	27.2
24	24	9.4	14.9	21.0
25	111	9.9	14.5	21.0
26	19	13.8	19.3	25.9
27	14	22.3	28.0	33.6
28	15	20.3	27.0	33.3
29	17	13.4	19.7	27.2
30	94	18.3	25.2	33.3
31	87	20.5	26.5	33.8
32	104	17.6	22.7	29.5

AVERAGE OF 1% AVERAGE VELOCITY = 17.24
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 23.96
AVERAGE OF 1% PEAK VELOCITY = 31.45

Table A2.1.3

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
80 FOOT SEPARATION --- SPRING PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PE[AK] VELOCITY
1	80	26.9	34.6	40.3
2	73	26.5	35.5	42.8
3	66	32.7	40.0	46.8
4	62	29.0	36.1	41.2
5	59	27.5	35.2	42.1
6	12	22.3	28.4	35.2
7	11	16.0	23.3	32.9
8	110	11.4	17.6	24.2
9	28	6.9	11.8	17.8
10	26	10.9	16.8	23.9
11	7	17.6	24.6	32.4
12	9	16.8	25.1	32.1
13	48	20.2	27.9	35.9
14	53	18.8	25.5	32.3
15	52	18.3	25.6	34.5
16	43	9.9	15.8	23.9
17	39	13.8	21.6	30.4
18	5	15.4	23.0	30.7
19	3	15.8	23.8	32.6
20	1	11.7	18.0	26.0
21	31	18.5	24.6	33.5
22	33	11.6	19.4	27.7
23	22	11.5	17.3	24.9
24	24	8.6	13.6	19.2
25	111	9.6	13.9	19.8
26	19	13.2	18.7	25.0
27	14	20.7	26.0	31.1
28	15	18.8	25.1	31.2
29	17	13.9	19.8	26.3
30	94	17.5	24.5	31.9
31	87	21.5	27.7	35.4
32	104	16.2	21.5	28.2

AVERAGE OF 1% AVERAGE VELOCITY = 17.18
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 23.81
AVERAGE OF 1% PEAK VELOCITY = 31.01

Table 2.1.4

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
60 FOOT SEPARATION --- SUMMER PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	90	19.3	25.1	30.1
2	73	19.0	26.3	33.2
3	66	23.0	28.2	33.8
4	62	21.9	27.2	31.4
5	59	18.5	24.3	30.4
6	12	16.5	21.1	26.4
7	11	14.4	20.5	27.9
8	110	8.9	13.8	19.2
9	28	5.9	10.0	14.8
10	26	8.5	13.3	18.9
11	7	15.1	21.0	26.7
12	9	14.6	21.7	27.5
13	48	17.6	24.1	30.0
14	53	16.0	21.6	26.7
15	52	13.9	19.6	26.4
16	43	8.5	13.6	20.0
17	39	11.8	18.3	25.2
18	5	12.7	19.0	25.2
19	3	13.4	20.3	27.7
20	1	10.6	15.9	22.0
21	31	13.9	18.8	26.1
22	33	8.9	14.9	21.5
23	22	8.7	13.0	18.8
24	24	6.5	10.4	14.9
25	111	7.2	10.4	15.0
26	19	10.4	15.1	20.2
27	14	15.7	19.8	23.6
28	15	14.8	19.4	24.1
29	17	11.8	16.4	21.1
30	94	14.0	19.4	24.8
31	87	17.8	22.5	28.5
32	104	12.2	16.7	22.4

AVERAGE OF 1% AVERAGE VELOCITY = 13.50
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 18.80
AVERAGE OF 1% PEAK VELOCITY = 24.52

Table A2.1.5
GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
60 FOOT SEPARATION --- FALL PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEA[K] VELOCITY
1	80	25.0	32.1	37.5
2	73	24.3	32.9	40.1
3	66	30.0	37.0	43.7
4	62	27.3	34.2	39.2
5	59	25.3	33.0	39.9
6	12	19.7	25.5	32.0
7	11	15.8	23.0	31.8
8	110	10.8	16.4	22.3
9	28	6.3	10.7	16.2
10	26	9.8	15.2	21.8
11	7	15.5	22.5	30.3
12	9	15.6	23.2	30.3
13	48	17.9	25.0	33.0
14	53	16.9	23.1	30.2
15	52	16.9	23.5	31.6
16	43	9.4	15.0	22.6
17	39	13.5	20.7	29.0
18	5	14.7	22.0	29.6
19	3	14.9	22.7	31.6
20	1	11.6	17.6	25.2
21	31	16.5	22.1	30.3
22	33	10.7	17.8	25.8
23	22	10.2	15.6	22.8
24	24	7.6	12.2	17.4
25	111	8.4	12.3	17.6
26	19	11.6	16.5	22.3
27	14	17.8	22.5	27.2
28	15	16.4	22.0	27.6
29	17	12.5	17.7	24.1
30	94	15.8	22.3	29.3
31	87	19.7	25.6	32.9
32	104	14.8	20.0	26.9

AVERAGE OF 1% AVERAGE VELOCITY = 15.72
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 21.94
AVERAGE OF 1% PEAK VELOCITY = 28.82

****
****

Table A2.2.1

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT   PHASE III
TREE CONFIGURATION I   --- ANNUAL PREDICITIONS ---   DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

****
****

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	11	9.8	14.6	20.5
2	12	8.7	13.1	18.8
3	62	25.7	31.8	36.8
4	66	28.6	34.9	40.9
5	80	22.0	29.1	35.8
6	73	21.9	29.8	38.4
7	59	22.6	29.9	36.6
8	14	9.9	14.1	18.2

AVERAGE OF 1% AVERAGE VELOCITY = 18.64
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 24.67
AVERAGE OF 1% PEAK VELOCITY = 30.77

Table A2.2.2

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

TREE CONFIGURATION I --- WINTER PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	11	10.3	15.7	22.4
2	12	9.5	14.0	19.7
3	62	26.5	33.0	38.6
4	66	30.6	37.7	44.3
5	80	21.8	29.4	37.1
6	73	22.9	31.0	40.7
7	59	23.0	30.7	37.9
8	14	11.2	15.8	20.4

AVERAGE OF 1% AVERAGE VELOCITY = 19.47
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 25.92
AVERAGE OF 1% PEAK VELOCITY = 32.64

Table A2.2.3

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION I --- SPRING PREDICTIONS --- OCT 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	11	10.2	15.2	21.2
2	12	9.3	14.0	20.2
3	62	27.7	34.1	39.0
4	66	30.6	37.0	43.0
5	80	24.2	31.6	38.3
6	73	23.5	31.9	40.7
7	59	25.1	33.0	40.2
8	14	10.3	14.7	19.0

AVERAGE OF 1% AVERAGE VELOCITY = 20.10
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 26.44
AVERAGE OF 1% PEAK VELOCITY = 32.71

Table A2.2.4

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION I --- SUMMER PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEA VELOCITY
1	11	7.7	11.5	16.0
2	12	6.8	10.2	14.6
3	62	20.9	25.9	30.3
4	66	21.4	26.4	31.8
5	80	17.6	23.3	29.0
6	73	18.2	25.0	32.0
7	59	16.9	22.6	28.0
8	14	7.5	10.9	14.3

AVERAGE OF 1% AVERAGE VELOCITY = 14.64
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 19.48
AVERAGE OF 1% PEAK VELOCITY = 24.49

Table A2.2.5
GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION I --- FALL PREDICITONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	11	9.9	14.5	20.0
2	12	8.4	13.0	19.2
3	62	26.1	32.3	37.2
4	66	28.1	34.3	40.2
5	80	22.5	29.8	36.1
6	73	21.3	28.9	37.2
7	59	23.1	30.7	37.4
9	14	8.9	12.7	16.7

AVERAGE OF 1% AVERAGE VELOCITY = 18.55
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 24.51
AVERAGE OF 1% PEAK VELOCITY = 30.51

Table A2.3.1

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION II --- ANNUAL PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	62	27.2	33.3	39.4
2	66	28.3	34.4	41.7
3	9	13.3	20.4	29.7
4	58	5.6	9.1	14.0
5	11	10.7	15.4	21.8
6	12	13.4	17.6	22.6
7	59	18.3	26.4	33.9
8	14	7.5	10.8	14.6

AVERAGE OF 1% AVERAGE VELOCITY = 15.51
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 20.93
AVERAGE OF 1% PEAK VELOCITY = 27.21

Table A2.3.2

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION II --- WINTER PREDICTIONS --- DEC 1994

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	62	28.0	34.6	41.0
2	66	30.6	37.5	45.2
3	9	13.9	21.5	32.2
4	58	5.8	9.5	14.8
5	11	11.5	16.6	23.5
6	12	12.4	16.7	22.2
7	59	19.0	27.5	35.3
8	14	8.4	12.0	15.9

AVERAGE OF 1% AVERAGE VELOCITY = 16.20
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 22.00
AVERAGE OF 1% PEAK VELOCITY = 28.76

Table A2.3.3

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION II --- SPRING PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PE[illegible] VELOCITY
1	62	29.1	35.5	41.7
2	66	29.9	36.2	43.4
3	9	14.1	21.4	30.9
4	58	5.7	9.4	14.6
5	11	11.0	15.9	22.6
6	12	15.5	20.1	25.3
7	[illegible]	[illegible]	28.2	36.1
8	14	8.1	11.7	15.5

AVERAGE OF 1% AVERAGE VELOCITY = 16.60
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 22.27
AVERAGE OF 1% PEAK VELOCITY = 28.76

Table A2.3.4
GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION II --- SUMMER PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	62	22.4	27.6	32.6
2	66	21.3	26.2	33.2
3	9	10.8	17.0	24.0
4	58	5.1	8.2	12.4
5	11	8.5	12.3	17.6
6	12	10.3	13.6	17.4
7	59	13.8	19.8	25.2
8	14	6.1	8.8	11.9

AVERAGE OF 1% AVERAGE VELOCITY = 12.30
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 16.69
AVERAGE OF 1% PEAK VELOCITY = 21.79

Table A2.3.5

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION II --- FALL PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	62	27.6	33.8	40.1
2	66	27.4	33.5	41.2
3	9	13.4	20.4	29.0
4	58	5.6	9.2	14.3
5	11	10.6	15.1	21.2
6	12	13.9	18.3	23.5
7	59	19.1	27.8	35.4
8	14	6.6	9.8	13.6

AVERAGE OF 1% AVERAGE VELOCITY = 15.54
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 20.99
AVERAGE OF 1% PEAK VELOCITY = 27.29

Table A2.4.1
GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION III --- ANNUAL PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	62	25.9	32.1	38.2
2	66	29.0	35.6	42.9
3	9	12.9	20.1	29.6
4	58	5.5	8.9	13.7
5	11	10.6	15.4	21.7
6	12	9.3	13.8	19.1
7	59	14.6	20.4	27.2
8	14	7.5	10.7	14.3

AVERAGE OF 1% AVERAGE VELOCITY = 14.42
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 19.65
AVERAGE OF 1% PEAK VELOCITY = 25.84

Table 2.4.2

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION III --- WINTER PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	62	26.6	33.3	39.8
2	66	31.2	38.4	46.2
3	9	13.5	21.2	32.1
4	58	5.7	9.4	14.4
5	11	11.5	16.7	23.6
6	12	9.5	14.2	19.8
7	59	15.1	21.2	28.5
8	14	8.3	12.0	15.7

AVERAGE OF 1% AVERAGE VELOCITY = 15.19
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 20.79
AVERAGE OF 1% PEAK VELOCITY = 27.50

Table A2.4.3
GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION III --- SPRING PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	62	27.5	34.1	40.5
2	66	30.8	37.7	44.9
3	9	13.6	21.0	30.8
4	58	5.6	9.1	14.1
5	11	10.9	15.9	22.5
6	12	10.3	15.1	20.8
7	59	15.9	22.1	29.4
8	14	8.1	11.6	15.2

AVERAGE OF 1% AVERAGE VELOCITY = 15.35
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 20.83
AVERAGE OF 1% PEAK VELOCITY = 27.26

Table A2.4.4

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

TREE CONFIGURATION III --- SUMMER PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	62	22.1	27.2	32.0
2	66	21.8	27.0	33.7
3	9	10.7	17.0	24.0
4	58	5.1	8.2	12.4
5	11	8.4	12.1	17.3
6	12	7.4	11.0	14.9
7	59	12.0	16.4	21.5
9	14	6.1	8.7	11.7

AVERAGE OF 1% AVERAGE VELOCITY = 11.68

AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 15.96

AVERAGE OF 1% PEAK VELOCITY = 20.93

Table A2.4.5

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION III --- FALL PREDICTIONS --- DEC 1984

1% WIND VELOCITIES FOR EACH GROUND STATION

HOT WIRE POINT	GROUND STATION	1% AVERAGE VELOCITY	1% EFF. PEAK VELOCITY	1% EST. PEAK VELOCITY
1	62	26.2	32.4	38.6
2	66	28.4	35.1	42.6
3	9	13.0	20.1	28.9
4	58	5.6	9.1	14.1
5	11	10.6	15.2	21.1
6	12	9.5	14.2	19.7
7	59	14.3	20.3	27.4
8	14	6.6	9.6	13.1

AVERAGE OF 1% AVERAGE VELOCITY = 14.28
AVERAGE OF 1% EFFECTIVE PEAK VELOCITY = 19.49
AVERAGE OF 1% PEAK VELOCITY = 25.69

****
****

Table A3.1.1

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 1 GROUND STATION 80

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.527	0.093	0.760	2.5
NE	0.593	0.107	0.850	2.4
ENE	0.574	0.114	0.844	2.4
E	0.220	0.070	0.525	4.3
ESE	0.527	0.082	0.769	3.0
SE	0.504	0.077	0.806	3.9
SSE	0.522	0.093	0.788	2.9
S	0.424	0.079	0.759	4.2
SSW	0.391	0.087	0.715	3.7
SW	0.431	0.101	0.739	3.1
WSW	0.391	0.108	0.708	2.9
W	0.382	0.130	0.740	2.8
WNW	0.387	0.120	0.702	2.6
NW	0.422	0.076	0.663	3.2
NNW	0.501	0.072	0.711	2.9
N	0.503	0.077	0.701	2.6

****
****
Table A3.1.2

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 2 GROUND STATION 73

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.338	0.128	0.772	3.4
NE	0.612	0.099	0.889	2.8
ENE	0.546	0.131	0.851	2.3
E	0.424	0.117	0.720	2.5
ESE	0.390	0.127	0.740	2.7
SE	0.256	0.097	0.555	3.1
SSE	0.413	0.165	0.779	2.2
S	0.581	0.111	0.909	3.0
SSW	0.437	0.183	0.933	2.7
SW	0.271	0.149	0.799	3.6
WSW	0.293	0.111	0.689	3.6
W	0.365	0.100	0.716	3.5
WNW	0.354	0.080	0.615	3.3
NW	0.391	0.090	0.671	3.1
NNW	0.376	0.083	0.700	3.9
N	0.347	0.096	0.638	3.0

Table 3.1.3

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 3 GROUND STATION 66

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.356	0.154	0.835	3.1
NE	0.593	0.103	0.865	2.6
ENE	0.732	0.099	1.020	2.9
E	0.748	0.119	1.123	3.2
ESE	0.659	0.088	0.927	3.1
SE	0.512	0.080	0.717	2.6
SSE	0.510	0.107	0.889	3.5
S	0.268	0.130	0.685	3.2
SSW	0.242	0.109	0.628	3.5
SW	0.247	0.170	0.791	3.2
WSW	0.393	0.115	0.783	3.4
W	0.589	0.069	0.847	3.7
WNW	0.563	0.081	0.832	3.3
NW	0.502	0.091	0.825	3.5
NNW	0.349	0.101	0.640	2.9
N	0.208	0.069	0.496	4.2

****
****

Table A3.1.4

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT   PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES   DEC 1984

HOT WIRE POINT 4   GROUND STATION 62

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.361	0.100	0.719	3.6
NE	0.579	0.101	0.797	2.2
ENE	0.580	0.102	0.846	2.6
E	0.597	0.098	0.872	2.8
ESE	0.590	0.114	0.964	3.3
SE	0.409	0.114	0.735	2.8
SSE	0.237	0.104	0.652	4.0
S	0.413	0.124	0.743	2.7
SSW	0.617	0.084	0.852	2.8
SW	0.535	0.104	0.848	3.0
WSW	0.368	0.082	0.603	2.9
W	0.380	0.089	0.667	3.2
WNW	0.325	0.084	0.610	3.4
NW	0.247	0.083	0.503	3.1
NNW	0.234	0.111	0.619	3.5
N	0.356	0.089	0.629	3.1

****
****

Table 3.1.5

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 5 GROUND STATION 59

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.367	0.167	0.828	2.7
NE	0.634	0.108	0.989	3.3
ENE	0.591	0.109	0.893	2.8
E	0.475	0.103	0.774	2.9
ESE	0.443	0.138	0.829	2.8
SE	0.396	0.094	0.695	3.2
SSE	0.452	0.097	0.693	2.5
S	0.473	0.103	0.736	2.6
SSW	0.370	0.104	0.763	3.8
SW	0.282	0.107	0.625	3.2
WSW	0.221	0.090	0.567	3.9
W	0.340	0.078	0.666	4.1
WNW	0.344	0.077	0.674	4.3
NW	0.271	0.095	0.629	3.7
NNW	0.313	0.102	0.662	3.4
N	0.321	0.099	0.650	3.3

****
****

Table A3.1.6

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 6 GROUND STATION 12

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.310	0.104	0.622	3.0
NE	0.352	0.084	0.611	3.1
ENE	0.400	0.083	0.708	3.7
E	0.321	0.072	0.593	3.8
ESE	0.269	0.072	0.546	3.8
SE	0.255	0.080	0.536	3.5
SSE	0.278	0.080	0.613	4.2
S	0.243	0.074	0.540	4.0
SSW	0.232	0.116	0.584	3.0
SW	0.263	0.113	0.615	3.1
WSW	0.242	0.085	0.539	3.5
W	0.430	0.085	0.709	3.3
WNW	0.504	0.078	0.779	3.5
NW	0.352	0.078	0.623	3.5
NNW	0.233	0.082	0.556	3.9
N	0.289	0.135	0.688	2.9

****
****

Table A3.1.7

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 7 GROUND STATION 11

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.185	0.103	0.580	3.8
NE	0.269	0.086	0.556	3.4
ENE	0.271	0.103	0.581	3.0
E	0.220	0.094	0.543	3.4
ESE	0.202	0.089	0.492	3.2
SE	0.256	0.100	0.567	3.1
SSE	0.235	0.119	0.659	3.6
S	0.106	0.070	0.462	5.1
SSW	0.203	0.134	0.818	4.6
SW	0.430	0.121	0.781	2.9
WSW	0.125	0.059	0.372	4.2
W	0.103	0.047	0.336	5.0
WNW	0.101	0.047	0.378	5.9
NW	0.100	0.052	0.326	4.3
NNW	0.061	0.037	0.292	6.3
N	0.121	0.059	0.380	4.4

****

Table A3.1.8

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 8 GROUND STATION 110

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.187	0.060	0.401	3.6
NE	0.133	0.058	0.342	3.6
ENE	0.093	0.044	0.280	4.3
E	0.025	0.032	0.205	5.5
ESE	0.063	0.050	0.229	3.3
SE	0.087	0.056	0.281	3.5
SSE	0.168	0.074	0.421	3.4
S	0.022	0.023	0.154	5.7
SSW	0.152	0.115	0.511	3.1
SW	0.145	0.083	0.456	3.7
WSW	0.148	0.064	0.369	3.5
W	0.075	0.036	0.181	3.0
WNW	0.175	0.094	0.482	3.3
NW	0.191	0.105	0.472	2.7
NNW	0.259	0.083	0.494	2.8
N	0.379	0.092	0.704	3.5

Table A3.1.9
GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 9 GROUND STATION 28

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.129	0.057	0.375	4.3
NE	0.093	0.051	0.261	3.3
ENE	0.061	0.031	0.215	5.0
E	0.102	0.046	0.245	3.1
ESE	0.087	0.044	0.259	3.9
SE	0.046	0.033	0.196	4.5
SSE	0.070	0.039	0.215	3.7
S	0.085	0.050	0.232	3.0
SSW	0.175	0.082	0.474	3.6
SW	0.066	0.044	0.328	6.0
WSW	0.018	0.020	0.121	5.1
W	0.047	0.037	0.205	4.3
WNW	0.083	0.052	0.331	4.8
NW	0.104	0.046	0.296	4.2
NNW	0.077	0.047	0.263	4.0
N	0.160	0.075	0.454	3.9

****

Table A3.1.10

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 10 GROUND STATION 26

****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.173	0.070	0.471	4.3
NE	0.150	0.071	0.416	3.8
ENE	0.087	0.032	0.237	4.7
E	0.105	0.053	0.288	3.5
ESE	0.170	0.048	0.335	3.4
SE	0.101	0.048	0.286	3.8
SSE	0.180	0.071	0.409	3.2
S	0.216	0.080	0.496	3.5
SSW	0.209	0.098	0.533	3.3
SW	0.119	0.060	0.379	4.3
WSW	0.084	0.037	0.216	3.6
W	0.138	0.069	0.438	4.4
WNW	0.240	0.082	0.496	3.1
NW	0.221	0.066	0.480	3.9
NNW	0.183	0.080	0.456	3.4
N	0.177	0.062	0.399	3.6

****
****

Table A3.1.11

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 11 GROUND STATION 7

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.200	0.084	0.553	4.2
NE	0.197	0.093	0.674	5.1
ENE	0.211	0.066	0.540	5.0
E	0.307	0.097	0.635	3.4
ESE	0.309	0.077	0.536	2.9
SE	0.208	0.055	0.392	3.4
SSE	0.275	0.091	0.600	3.6
S	0.366	0.095	0.672	3.2
SSW	0.458	0.110	0.819	3.3
SW	0.288	0.129	0.640	2.7
WSW	0.243	0.077	0.498	3.3
W	0.275	0.098	0.582	3.1
WNW	0.217	0.101	0.548	3.3
NW	0.232	0.080	0.541	3.8
NNW	0.276	0.087	0.570	3.4
N	0.269	0.082	0.587	3.9

****
****

Table A3.1.12

ROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
WIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 12 GROUND STATION 9

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.154	0.067	0.422	4.0
NE	0.200	0.073	0.570	5.1
ENE	0.224	0.068	0.547	4.7
E	0.208	0.077	0.544	4.4
ESE	0.167	0.070	0.393	3.3
SE	0.190	0.110	0.570	3.4
SSE	0.281	0.104	0.609	3.1
S	0.239	0.087	0.502	3.0
SSW	0.415	0.140	0.783	2.6
SW	0.383	0.121	0.740	3.0
WSW	0.240	0.066	0.438	3.0
W	0.246	0.082	0.554	3.8
WNW	0.265	0.091	0.568	3.3
NW	0.190	0.079	0.485	3.7
NNW	0.102	0.072	0.440	4.7
N	0.205	0.080	0.475	3.4

****

Table A3.1.13

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 13 GROUND STATION 48

****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.250	0.084	0.549	3.5
NE	0.233	0.068	0.569	4.9
ENE	0.232	0.096	0.685	4.7
E	0.234	0.122	0.639	3.3
ESE	0.155	0.088	0.537	4.3
SE	0.163	0.082	0.484	3.9
SSE	0.260	0.112	0.710	4.0
S	0.444	0.154	0.928	3.2
SSW	0.524	0.121	0.861	2.8
SW	0.393	0.105	0.773	3.6
WSW	0.115	0.079	0.385	3.4
W	0.079	0.062	0.357	4.5
WNW	0.072	0.044	0.261	4.3
NW	0.070	0.056	0.319	4.4
NNW	0.201	0.083	0.537	4.0
N	0.215	0.083	0.498	3.4

****
****

Table A3.1.14

ROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

WIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 14 GROUND STATION 53

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.292	0.077	0.587	3.8
NE	0.286	0.061	0.511	3.7
ENE	0.289	0.081	0.642	4.4
E	0.268	0.095	0.581	3.3
ESE	0.225	0.078	0.485	3.3
SE	0.260	0.071	0.505	3.5
SSE	0.392	0.122	0.825	3.5
S	0.468	0.115	0.825	3.1
SSW	0.465	0.106	0.760	2.8
SW	0.340	0.084	0.692	4.2
WSW	0.265	0.065	0.538	4.2
W	0.230	0.069	0.467	3.4
WNW	0.127	0.071	0.560	6.1
NW	0.146	0.067	0.403	3.9
NNW	0.112	0.064	0.331	3.4
N	0.174	0.070	0.480	4.4

Table A3.1.15

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 15 GROUND STATION 52

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.377	0.068	0.602	3.3
NE	0.331	0.068	0.641	4.6
ENE	0.288	0.070	0.566	4.0
E	0.251	0.080	0.535	3.5
ESE	0.226	0.096	0.582	3.7
SE	0.186	0.079	0.520	4.2
SSE	0.219	0.085	0.645	5.0
S	0.299	0.093	0.596	3.2
SSW	0.317	0.102	0.683	3.6
SW	0.195	0.076	0.476	3.7
WSW	0.183	0.079	0.538	4.5
W	0.268	0.084	0.614	4.1
WNW	0.399	0.113	0.727	2.9
NW	0.340	0.096	0.695	3.7
NNW	0.166	0.091	0.616	4.9
N	0.257	0.087	0.503	2.8

****
****

Table A3.1.16

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 16 GROUND STATION 43

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.036	0.028	0.217	6.5
NE	0.055	0.042	0.247	4.6
ENE	0.095	0.048	0.322	4.7
E	0.085	0.055	0.307	4.1
ESE	0.051	0.041	0.222	4.2
SE	0.096	0.067	0.297	3.0
SSE	0.074	0.065	0.293	3.4
S	0.047	0.050	0.295	4.9
SSW	0.207	0.083	0.475	3.2
SW	0.247	0.099	0.559	3.2
WSW	0.181	0.068	0.505	4.8
W	0.203	0.066	0.440	3.6
WNW	0.138	0.067	0.450	4.7
NW	0.103	0.066	0.468	5.5
NNW	0.116	0.083	0.447	4.0
N	0.172	0.116	0.673	4.3

Table A3.1.17

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 17 GROUND STATION 39

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.147	0.075	0.430	3.7
NE	0.173	0.078	0.449	3.6
ENE	0.201	0.066	0.421	3.3
E	0.294	0.104	0.732	4.2
ESE	0.313	0.110	0.688	3.4
SE	0.106	0.071	0.453	4.9
SSE	0.190	0.094	0.492	3.2
S	0.220	0.082	0.476	3.1
SSW	0.286	0.137	0.739	3.3
SW	0.346	0.110	0.685	3.1
WSW	0.190	0.077	0.554	4.7
W	0.137	0.066	0.392	3.8
WNW	0.129	0.077	0.431	3.9
NW	0.164	0.069	0.425	3.8
NNW	0.167	0.086	0.419	2.9
N	0.139	0.064	0.365	3.5

****
****

Table A3.1.18

ROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
WIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 18 GROUND STATION 5

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.303	0.124	0.680	3.0
NE	0.279	0.088	0.545	3.0
ENE	0.233	0.063	0.615	6.0
E	0.289	0.076	0.566	3.6
ESE	0.310	0.093	0.631	3.4
SE	0.172	0.080	0.404	2.9
SSE	0.133	0.060	0.342	3.5
S	0.189	0.096	0.584	4.1
SSW	0.374	0.120	0.754	3.2
SW	0.297	0.099	0.597	3.0
WSW	0.193	0.073	0.451	3.5
W	0.210	0.071	0.485	3.9
WNW	0.110	0.069	0.429	4.6
NW	0.064	0.044	0.304	5.4
NNW	0.078	0.063	0.384	4.9
N	0.139	0.088	0.520	4.3

Table A3.1.19

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT   PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES   DEC 1984

HOT WIRE POINT 19   GROUND STATION 3

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.219	0.102	0.580	3.5
NE	0.166	0.084	0.520	4.2
ENE	0.184	0.073	0.429	3.4
E	0.234	0.105	0.659	4.0
ESE	0.366	0.091	0.660	3.2
SE	0.264	0.084	0.499	2.8
SSE	0.217	0.090	0.482	2.9
S	0.247	0.080	0.573	4.1
SSW	0.335	0.123	0.732	3.2
SW	0.374	0.123	0.842	3.8
WSW	-.010	0.001	-.009	0.5
W	0.127	0.064	0.368	3.8
WNW	0.163	0.087	0.532	4.2
NW	0.260	0.105	0.595	3.2
NNW	0.222	0.080	0.491	3.4
N	0.217	0.074	0.477	3.5

****
****

Table A3.1.20

ROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
WIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 20 GROUND STATION 1

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.115	0.062	0.455	5.5
NE	0.123	0.077	0.478	4.6
ENE	0.162	0.058	0.362	3.4
E	0.178	0.080	0.505	4.1
ESE	0.202	0.107	0.566	3.4
SE	0.274	0.090	0.514	2.7
SSE	0.218	0.111	0.592	3.4
S	0.162	0.075	0.438	3.7
SSW	0.215	0.108	0.662	4.1
SW	0.319	0.100	0.624	3.1
WSW	0.148	0.066	0.420	4.1
W	0.154	0.047	0.326	3.6
WNW	0.164	0.053	0.412	4.7
NW	0.138	0.064	0.384	3.9
NNW	0.136	0.079	0.497	4.6
N	0.129	0.084	0.513	4.6

****

****

Table A3.1.21

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 21 GROUND STATION 31

****

****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.135	0.074	0.482	4.7
NE	0.134	0.072	0.402	3.7
ENE	0.256	0.073	0.524	3.7
E	0.329	0.076	0.566	3.1
ESE	0.270	0.087	0.641	4.3
SE	0.371	0.096	0.639	2.8
SSE	0.369	0.101	0.760	3.9
S	0.284	0.123	0.727	3.6
SSW	0.238	0.096	0.640	4.2
SW	0.245	0.104	0.574	3.2
WSW	0.189	0.085	0.455	3.1
W	0.270	0.081	0.542	3.3
WNW	0.376	0.087	0.750	4.3
NW	0.417	0.081	0.751	4.1
NNW	0.317	0.099	0.680	3.7
N	0.217	0.075	0.537	4.2

****
****

Table A3.1.22

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 22 GROUND STATION 33

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.268	0.097	0.579	3.2
NE	0.184	0.079	0.461	3.5
ENE	0.134	0.073	0.379	3.4
E	0.101	0.060	0.346	4.1
ESE	0.138	0.087	0.517	4.3
SE	0.128	0.056	0.401	4.8
SSE	0.132	0.068	0.364	3.4
S	0.145	0.078	0.398	3.3
SSW	0.163	0.082	0.436	3.3
SW	0.111	0.080	0.519	5.1
WSW	0.087	0.052	0.368	5.4
W	0.213	0.090	0.517	3.4
WNW	0.217	0.093	0.489	2.9
NW	0.245	0.120	0.637	3.3
NNW	0.224	0.116	0.637	3.6
N	0.237	0.100	0.538	3.0

Table A3.1.23

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT   PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES   DEC 1984

HOT WIRE POINT 23   GROUND STATION 22

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.146	0.059	0.415	4.5
NE	0.154	0.072	0.459	4.2
ENE	0.142	0.050	0.420	5.5
E	0.178	0.073	0.434	3.5
ESE	0.098	0.052	0.360	5.1
SE	0.068	0.042	0.239	4.1
SSE	0.114	0.054	0.317	3.8
S	0.132	0.046	0.294	3.5
SSW	0.118	0.059	0.416	5.0
SW	0.142	0.067	0.404	3.9
WSW	0.097	0.049	0.318	4.6
W	0.155	0.058	0.422	4.6
WNW	0.245	0.079	0.529	3.6
NW	0.253	0.087	0.595	3.9
NNW	0.165	0.064	0.465	4.7
N	0.153	0.054	0.341	3.5

****
****

Table A3.1.24

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 24 GROUND STATION 24

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.083	0.046	0.290	4.5
NE	0.062	0.042	0.256	4.6
ENE	0.067	0.041	0.252	4.5
E	0.126	0.057	0.322	3.4
ESE	0.118	0.057	0.323	3.6
SE	0.098	0.050	0.239	2.8
SSE	0.085	0.063	0.307	3.5
S	0.065	0.038	0.217	3.9
SSW	0.109	0.046	0.272	3.6
SW	0.161	0.064	0.398	3.7
WSW	0.041	0.037	0.233	5.2
W	0.060	0.041	0.223	3.9
WNW	0.137	0.058	0.362	3.9
NW	0.206	0.080	0.443	3.0
NNW	0.102	0.062	0.367	4.3
N	0.086	0.044	0.261	4.0

****

Table A3.1.25

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 25 GROUND STATION 111

****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.047	0.035	0.264	6.2
NE	0.085	0.050	0.294	4.2
ENE	0.163	0.050	0.309	2.9
E	0.201	0.049	0.388	3.8
ESE	0.237	0.045	0.384	3.3
SE	0.125	0.042	0.267	3.4
SSE	0.046	0.043	0.226	4.2
S	0.012	0.014	0.140	9.3
SSW	0.076	0.052	0.242	3.2
SW	0.096	0.058	0.334	4.1
WSW	0.053	0.049	0.277	4.6
W	0.213	0.072	0.475	3.6
WNW	0.185	0.058	0.435	4.3
NW	0.088	0.038	0.294	5.5
NNW	0.170	0.067	0.413	3.6
N	0.021	0.012	0.099	6.4

Table A3.1.26

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 26 GROUND STATION 19

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.108	0.049	0.366	5.2
NE	0.076	0.039	0.276	5.2
ENE	0.175	0.075	0.427	3.4
E	0.175	0.060	0.406	3.8
ESE	0.299	0.076	0.556	3.4
SE	0.188	0.083	0.455	3.2
SSE	0.191	0.083	0.472	3.4
S	0.230	0.120	0.690	3.8
SSW	0.287	0.090	0.556	3.0
SW	0.151	0.071	0.431	4.0
WSW	0.112	0.063	0.315	3.2
W	0.227	0.058	0.493	4.6
WNW	0.280	0.062	0.532	4.1
NW	0.240	0.073	0.481	3.3
NNW	0.158	0.054	0.382	4.2
N	0.142	0.047	0.344	4.3

****

Table A3.1.27
GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 27 GROUND STATION 14

****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.202	0.069	0.457	3.7
NE	0.137	0.067	0.435	4.5
ENE	0.188	0.071	0.419	3.3
E	0.225	0.078	0.477	3.2
ESE	0.293	0.070	0.545	3.6
SE	0.163	0.087	0.505	3.9
SSE	0.203	0.069	0.463	3.7
S	0.197	0.063	0.403	3.3
SSW	0.151	0.043	0.325	4.1
SW	0.230	0.083	0.469	2.9
WSW	0.171	0.080	0.457	3.6
W	0.421	0.078	0.666	3.1
WNW	0.471	0.076	0.707	3.1
NW	0.365	0.071	0.568	2.9
NNW	0.304	0.069	0.494	2.8
N	0.174	0.073	0.478	4.2

****
****

Table A3.1.28

ROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

WIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 28 GROUND STATION 15

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.204	0.088	0.477	3.1
NE	0.223	0.084	0.568	4.1
ENE	0.272	0.072	0.475	2.8
E	0.270	0.077	0.489	2.8
ESE	0.358	0.075	0.614	3.4
SE	0.199	0.113	0.595	3.5
SSE	0.313	0.113	0.645	2.9
S	0.469	0.070	0.730	3.7
SSW	0.206	0.073	0.439	3.2
SW	0.093	0.042	0.286	4.6
WSW	0.105	0.083	0.488	4.6
W	0.339	0.111	0.721	3.4
WNW	0.420	0.086	0.673	2.9
NW	0.341	0.079	0.569	2.9
NNW	0.283	0.065	0.478	3.0
N	0.138	0.059	0.328	3.2

Table A3.1.29

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 29 GROUND STATION 17

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.157	0.090	0.423	3.0
NE	0.229	0.064	0.486	4.0
ENE	0.153	0.053	0.349	3.7
E	0.136	0.060	0.391	4.3
ESE	0.236	0.089	0.514	3.1
SE	0.207	0.065	0.474	4.1
SSE	0.266	0.094	0.605	3.6
S	0.219	0.079	0.539	4.1
SSW	0.356	0.088	0.600	2.8
SW	0.251	0.052	0.444	3.7
WSW	0.111	0.067	0.354	3.6
W	0.171	0.077	0.432	3.4
WNW	0.248	0.091	0.555	3.4
NW	0.174	0.072	0.475	4.2
NNW	0.178	0.085	0.447	3.2
N	0.126	0.060	0.435	5.1

****
****

Table A3.1.30

ROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
WIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 30 GROUND STATION 94

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.148	0.075	0.434	3.8
NE	0.165	0.063	0.386	3.5
ENE	0.144	0.064	0.564	6.6
E	0.321	0.136	0.685	2.7
ESE	0.384	0.104	0.707	3.1
SE	0.137	0.084	0.451	3.7
SSE	0.244	0.119	0.617	3.1
S	0.445	0.100	0.775	3.3
SSW	0.355	0.108	0.671	2.9
SW	0.197	0.084	0.488	3.5
WSW	0.046	0.040	0.256	5.3
W	0.175	0.057	0.388	3.8
WNW	0.263	0.066	0.497	3.5
NW	0.379	0.084	0.674	3.5
NNW	0.328	0.104	0.672	3.3
N	0.290	0.091	0.593	3.4

Table A3.1.31

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 31 GROUND STATION 87

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.411	0.076	0.670	3.4
NE	0.357	0.077	0.637	3.6
ENE	0.386	0.105	0.749	3.4
E	0.144	0.063	0.382	3.8
ESE	0.164	0.059	0.391	3.8
SE	0.372	0.076	0.629	3.4
SSE	0.479	0.089	0.775	3.3
S	0.519	0.083	0.791	3.3
SSW	0.509	0.082	0.820	3.8
SW	0.393	0.094	0.715	3.4
WSW	0.250	0.080	0.568	4.0
W	0.179	0.085	0.429	3.0
WNW	0.125	0.056	0.358	4.1
NW	0.210	0.076	0.452	3.2
NNW	0.222	0.100	0.540	3.2
N	0.367	0.085	0.678	3.7

****
****

Table A3.1.32

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

HOT WIRE POINT 32 GROUND STATION 104

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.143	0.083	0.510	4.4
NE	0.226	0.083	0.485	3.1
ENE	0.310	0.089	0.577	3.0
E	0.329	0.070	0.632	4.4
ESE	0.232	0.090	0.525	3.3
SE	0.348	0.084	0.616	3.2
SSE	0.410	0.091	0.719	3.4
S	0.222	0.070	0.484	3.7
SSW	0.143	0.093	0.505	3.9
SW	0.300	0.104	0.679	3.7
WSW	0.137	0.064	0.358	3.5
W	0.226	0.053	0.421	3.7
WNW	0.333	0.050	0.531	3.9
NW	0.332	0.058	0.564	4.0
NNW	0.248	0.067	0.499	3.7
N	0.190	0.084	0.477	3.4

Table A3.2.1
GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 1 GROUND STATION 11

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.291	0.070	0.558	3.8
NE	0.174	0.067	0.369	2.9
ENE	0.070	0.036	0.222	4.2
E	0.010	0.009	0.079	8.1
ESE	0.032	0.022	0.725	32.1
SE	0.060	0.024	0.174	4.7
SSE	0.109	0.061	0.330	3.6
S	0.068	0.041	0.251	4.5
SSW	0.067	0.052	0.340	5.3
SW	0.090	0.042	0.255	3.9
WSW	0.079	0.031	0.206	4.1
W	0.128	0.047	0.341	4.5
WNW	0.084	0.031	0.202	3.8
NW	0.171	0.089	0.476	3.4
NNW	0.192	0.058	0.367	3.0
N	0.257	0.067	0.448	2.8

****
****

Table A3.2.2
OUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
EE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 2 GROUND STATION 12

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.118	0.072	0.398	3.9
NE	0.184	0.078	0.450	3.4
ENE	0.158	0.064	0.433	4.3
E	0.186	0.060	0.425	4.0
ESE	0.246	0.060	0.446	3.3
SE	0.124	0.043	0.336	4.9
SSE	0.132	0.046	0.335	4.4
S	0.146	0.049	0.330	3.7
SSW	0.143	0.077	0.359	2.8
SW	0.076	0.051	0.345	5.3
WSW	0.067	0.033	0.213	4.5
W	0.103	0.045	0.280	3.9
WNW	0.180	0.048	0.309	2.7
NW	0.115	0.038	0.262	3.9
NNW	0.138	0.054	0.384	4.6
N	0.080	0.052	0.324	4.7

Table A3.2.3
GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 3 GROUND STATION 62

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.314	0.081	0.670	4.4
NE	0.574	0.093	0.806	2.5
ENE	0.568	0.082	0.770	2.5
E	0.527	0.091	0.828	3.3
ESE	0.544	0.113	0.885	3.0
SE	0.376	0.093	0.702	3.5
SSE	0.246	0.113	0.620	3.3
S	0.451	0.114	0.723	2.4
SSW	0.582	0.071	0.774	2.7
SW	0.513	0.105	0.845	3.2
WSW	0.385	0.077	0.625	3.1
W	0.339	0.079	0.621	3.6
WNW	0.316	0.079	0.588	3.4
NW	0.271	0.097	0.649	3.9
NNW	0.256	0.100	0.536	2.8
N	0.343	0.079	0.567	2.8

Table A3.2.4

OUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
EE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 4 GROUND STATION 66

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.322	0.160	0.733	2.6
NE	0.628	0.080	0.839	2.6
ENE	0.674	0.084	0.939	3.2
E	0.620	0.091	0.914	3.2
ESE	0.626	0.096	0.932	3.2
SE	0.451	0.090	0.695	2.7
SSE	0.455	0.115	0.780	2.8
S	0.279	0.110	0.674	3.6
SSW	0.313	0.123	0.633	2.6
SW	0.252	0.174	0.810	3.2
WSW	0.383	0.129	0.810	3.3
W	0.529	0.074	0.777	3.4
WNW	0.524	0.087	0.854	3.8
NW	0.507	0.096	0.783	2.9
NNW	0.366	0.109	0.660	2.7
N	0.243	0.087	0.528	3.3

Table A3.2.5

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 5 GROUND STATION 80

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.465	0.133	0.803	2.5
NE	0.612	0.109	0.933	2.9
ENE	0.269	0.067	0.542	4.1
E	0.202	0.089	0.441	2.7
ESE	0.330	0.075	0.537	2.7
SE	0.362	0.050	0.551	3.8
SSE	0.386	0.077	0.629	3.2
S	0.397	0.071	0.675	3.9
SSW	0.330	0.072	0.546	3.0
SW	0.415	0.096	0.783	3.9
WSW	0.385	0.080	0.648	3.3
W	0.431	0.098	0.711	2.9
WNW	0.319	0.102	0.678	3.5
NW	0.249	0.051	0.397	2.9
NNW	0.286	0.053	0.478	3.7
N	0.340	0.060	0.687	5.8

Table A3.2.6

OUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
EE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 6 GROUND STATION 73

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.257	0.105	0.687	4.1
NE	0.460	0.098	0.781	3.3
ENE	0.455	0.088	0.712	2.9
E	0.376	0.099	0.725	3.5
ESE	0.372	0.100	0.693	3.2
SE	0.284	0.107	0.653	3.4
SSE	0.304	0.112	0.650	3.1
S	0.591	0.117	0.918	2.8
SSW	0.479	0.139	0.878	2.9
SW	0.322	0.120	0.814	4.1
WSW	0.315	0.121	0.755	3.6
W	0.437	0.120	0.875	3.6
WNW	0.352	0.071	0.703	4.9
NW	0.383	0.082	0.645	3.2
NNW	0.370	0.075	0.634	3.5
N	0.342	0.086	0.621	3.2

Table A3.2.7

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 7 GROUND STATION 59

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.394	0.129	0.696	2.3
NE	0.579	0.125	0.942	2.9
ENE	0.542	0.103	0.872	3.2
E	0.410	0.076	0.678	3.5
ESE	0.391	0.109	0.778	3.6
SE	0.272	0.102	0.610	3.3
SSE	0.341	0.086	0.585	2.8
S	0.386	0.071	0.596	3.0
SSW	0.292	0.061	0.486	3.2
SW	0.235	0.108	0.676	4.1
WSW	0.182	0.108	0.682	4.6
W	0.221	0.080	0.517	3.7
WNW	0.145	0.062	0.366	3.6
NW	0.279	0.123	0.660	3.1
NNW	0.388	0.092	0.653	2.9
N	0.263	0.096	0.631	3.8

****
****

Table A3.2.8

OUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
EE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 8 GROUND STATION 14

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.072	0.034	0.255	5.4
NE	0.045	0.021	0.150	5.1
ENE	0.030	0.013	0.106	5.9
E	0.130	0.046	0.337	4.5
ESE	0.020	0.008	0.055	4.4
SE	0.055	0.033	0.173	3.6
SSE	0.121	0.042	0.266	3.4
S	0.160	0.062	0.351	3.1
SSW	0.122	0.039	0.274	3.8
SW	0.058	0.026	0.160	3.9
WSW	0.042	0.026	0.153	4.3
W	0.179	0.074	0.384	2.8
WNW	0.087	0.047	0.314	4.8
NW	0.245	0.066	0.444	3.0
NNW	0.039	0.035	0.217	5.1
N	0.051	0.036	0.218	4.6

Table A3.3.1

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 2 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 1 GROUND STATION 62

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.427	0.108	0.842	3.8
NE	0.581	0.081	0.823	3.0
ENE	0.556	0.084	0.831	3.3
E	0.607	0.089	0.880	3.1
ESE	0.550	0.093	0.821	2.9
SE	0.390	0.133	0.731	2.6
SSE	0.235	0.140	0.732	3.6
S	0.521	0.149	0.869	2.3
SSW	0.626	0.080	0.868	3.0
SW	0.569	0.091	0.846	3.0
WSW	0.407	0.081	0.672	3.3
W	0.347	0.087	0.743	4.6
WNW	0.351	0.094	0.657	3.2
NW	0.277	0.102	0.581	3.0
NNW	0.256	0.101	0.638	3.8
N	0.345	0.079	0.604	3.3

Table A3.3.2

)UND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
=E CONFIGURATION 2 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 2 GROUND STATION 66

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.252	0.136	0.918	4.9
NE	0.588	0.083	0.822	2.8
ENE	0.608	0.066	0.804	2.9
E	0.649	0.091	0.965	3.5
ESE	0.605	0.090	0.894	3.2
SE	0.494	0.085	0.761	3.1
SSE	0.486	0.147	0.821	2.3
S	0.301	0.119	0.697	3.3
SSW	0.354	0.142	0.746	2.8
SW	0.278	0.192	0.874	3.1
WSW	0.422	0.120	0.758	2.8
W	0.560	0.066	0.812	3.8
WNW	0.541	0.077	0.803	3.4
NW	0.530	0.098	0.831	3.1
NNW	0.382	0.104	0.670	2.8
N	0.214	0.072	0.467	3.5

Table A3.3.3

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 3 GROUND STATION 9

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.177	0.072	0.493	4.4
NE	0.268	0.078	0.543	3.5
ENE	0.288	0.070	0.548	3.7
E	0.310	0.103	0.676	3.6
ESE	0.261	0.093	0.560	3.2
SE	0.175	0.071	0.394	3.1
SSE	0.232	0.077	0.489	3.3
S	0.278	0.093	0.579	3.2
SSW	0.268	0.118	0.654	3.3
SW	0.295	0.113	0.622	2.9
WSW	0.174	0.065	0.438	4.1
W	0.227	0.082	0.543	3.9
WNW	0.226	0.101	0.647	4.2
NW	0.168	0.081	0.516	4.3
NNW	0.117	0.079	0.451	4.2
N	0.155	0.082	0.534	4.6

****
****

Table A3.3.4

)UND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
:E CONFIGURATION 2 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 4 GROUND STATION 58

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.060	0.038	0.209	3.9
NE	0.063	0.044	0.242	4.1
ENE	0.101	0.054	0.302	3.7
E	0.102	0.049	0.299	4.1
ESE	0.084	0.041	0.253	4.1
SE	0.085	0.060	0.304	3.7
SSE	0.099	0.074	0.352	3.4
S	0.086	0.055	0.271	3.4
SSW	0.046	0.044	0.236	4.3
SW	0.154	0.061	0.386	3.8
WSW	0.066	0.038	0.219	4.0
W	0.068	0.033	0.187	3.6
WNW	0.066	0.044	0.217	3.4
NW	0.045	0.029	0.187	4.9
NNW	0.025	0.020	0.128	5.1
N	0.068	0.040	0.217	3.7

Table A3.3.5

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

TREE CONFIGURATION 2 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 5 GROUND STATION 11

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.293	0.081	0.576	3.5
NE	0.043	0.025	0.139	3.9
ENE	0.104	0.052	0.296	3.7
E	0.006	0.018	0.140	7.3
ESE	0.008	0.010	0.099	9.4
SE	0.050	0.032	0.218	5.2
SSE	0.065	0.041	0.227	4.0
S	0.067	0.039	0.229	4.2
SSW	0.110	0.091	0.475	4.0
SW	0.065	0.029	0.192	4.4
WSW	0.070	0.032	0.233	5.0
W	0.070	0.026	0.184	4.3
WNW	0.086	0.027	0.207	4.4
NW	0.197	0.076	0.475	3.6
NNW	0.216	0.059	0.420	3.5
N	0.314	0.079	0.559	3.1

****
****

Table A3.3.6

OUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT   PHASE III
EE CONFIGURATION 2 - TOWERS SEPARATED BY 60 FEET   DEC 1984

HOT WIRE POINT 6   GROUND STATION 12

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.198	0.079	0.518	4.1
NE	0.409	0.078	0.663	3.3
ENE	0.201	0.049	0.380	3.7
E	0.158	0.043	0.329	3.9
ESE	0.195	0.051	0.414	4.3
SE	0.132	0.045	0.267	3.0
SSE	0.146	0.059	0.355	3.6
S	0.133	0.049	0.367	4.8
SSW	0.181	0.065	0.369	2.9
SW	0.040	0.028	0.199	5.6
WSW	0.083	0.043	0.277	4.5
W	0.158	0.054	0.324	3.1
WNW	0.069	0.030	0.245	5.9
NW	0.090	0.027	0.227	5.0
NNW	0.097	0.049	0.322	4.5
N	0.130	0.068	0.400	4.0

****
****

Table A3.3.7

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 2 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 7 GROUND STATION 59

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.445	0.167	0.880	2.6
NE	0.436	0.125	0.875	3.5
ENE	0.320	0.102	0.646	3.2
E	0.426	0.093	0.741	3.4
ESE	0.376	0.103	0.686	3.0
SE	0.241	0.081	0.494	3.1
SSE	0.385	0.094	0.684	3.2
S	0.363	0.075	0.616	3.4
SSW	0.269	0.066	0.479	3.2
SW	0.158	0.066	0.514	5.4
WSW	0.122	0.056	0.426	5.4
W	0.136	0.035	0.264	3.6
WNW	0.119	0.048	0.302	3.8
NW	0.065	0.034	0.209	4.3
NNW	0.066	0.029	0.302	8.0
N	0.167	0.066	0.392	3.4

****
****

Table A3.3.8

UND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
E CONFIGURATION 2 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 8 GROUND STATION 14

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.110	0.059	0.332	3.8
NE	0.042	0.025	0.221	7.2
ENE	0.044	0.018	0.106	3.3
E	0.027	0.018	0.086	3.4
ESE	0.035	0.017	0.098	3.6
SE	0.068	0.043	0.257	4.4
SSE	0.156	0.063	0.373	3.5
S	0.102	0.038	0.300	5.2
SSW	0.099	0.041	0.308	5.0
SW	0.074	0.035	0.239	4.8
WSW	0.051	0.037	0.227	4.8
W	0.210	0.061	0.390	3.0
WNW	0.045	0.026	0.226	7.0
NW	0.071	0.040	0.281	5.2
NNW	0.109	0.040	0.247	3.5
N	0.081	0.040	0.237	3.9

Table A3.4.1
GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 1 GROUND STATION 62

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.257	0.079	0.577	4.1
NE	0.509	0.097	0.782	2.8
ENE	0.444	0.081	0.760	3.9
E	0.607	0.089	0.880	3.1
ESE	0.550	0.093	0.821	2.9
SE	0.390	0.133	0.731	2.6
SSE	0.235	0.140	0.732	3.6
S	0.521	0.149	0.869	2.3
SSW	0.626	0.080	0.868	3.0
SW	0.569	0.091	0.846	3.0
WSW	0.407	0.081	0.672	3.3
W	0.347	0.087	0.743	4.6
WNW	0.351	0.094	0.657	3.2
NW	0.277	0.102	0.581	3.0
NNW	0.256	0.101	0.638	3.8
N	0.345	0.079	0.604	3.3

Table A3.4.2

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 2 GROUND STATION 66

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.314	0.183	0.839	2.9
NE	0.640	0.090	0.952	3.5
ENE	0.638	0.098	0.936	3.0
E	0.649	0.091	0.965	3.5
ESE	0.605	0.090	0.894	3.2
SE	0.494	0.085	0.761	3.1
SSE	0.486	0.147	0.821	2.3
S	0.301	0.119	0.697	3.3
SSW	0.354	0.142	0.746	2.8
SW	0.278	0.192	0.874	3.1
WSW	0.422	0.120	0.758	2.8
W	0.560	0.066	0.812	3.8
WNW	0.541	0.077	0.803	3.4
NW	0.530	0.098	0.831	3.1
NNW	0.382	0.104	0.670	2.8
N	0.214	0.072	0.467	3.5

Table A3.4.3

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III

TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 3 GROUND STATION 9

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.181	0.071	0.512	4.7
NE	0.247	0.077	0.582	4.4
ENE	0.255	0.065	0.474	3.4
E	0.310	0.103	0.676	3.6
ESE	0.261	0.093	0.560	3.2
SE	0.175	0.071	0.394	3.1
SSE	0.232	0.077	0.489	3.3
S	0.278	0.093	0.579	3.2
SSW	0.268	0.118	0.654	3.3
SW	0.295	0.113	0.622	2.9
WSW	0.174	0.065	0.438	4.1
W	0.227	0.082	0.543	3.9
WNW	0.226	0.101	0.647	4.2
NW	0.168	0.081	0.516	4.3
NNW	0.117	0.079	0.451	4.2
N	0.155	0.082	0.534	4.6

****
****

Table A3.4.4

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 4 GROUND STATION 58

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.068	0.039	0.278	5.4
NE	0.080	0.045	0.240	3.6
ENE	0.072	0.037	0.213	3.8
E	0.102	0.049	0.299	4.1
ESE	0.084	0.041	0.253	4.1
SE	0.085	0.060	0.304	3.7
SSE	0.099	0.074	0.352	3.4
S	0.086	0.055	0.271	3.4
SSW	0.046	0.044	0.236	4.3
SW	0.154	0.061	0.386	3.8
WSW	0.066	0.038	0.219	4.0
W	0.068	0.033	0.187	3.6
WNW	0.066	0.044	0.217	3.4
NW	0.045	0.029	0.187	4.9
NNW	0.025	0.020	0.128	5.1
N	0.068	0.040	0.217	3.7

Table A3.4.5

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 5 GROUND STATION 11

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.267	0.069	0.520	3.7
NE	0.197	0.067	0.402	3.0
ENE	0.073	0.052	0.283	4.0
E	0.006	0.018	0.140	7.3
ESE	0.008	0.010	0.099	9.4
SE	0.050	0.032	0.218	5.2
SSE	0.065	0.041	0.227	4.0
S	0.067	0.039	0.229	4.2
SSW	0.110	0.091	0.475	4.0
SW	0.065	0.029	0.192	4.4
WSW	0.070	0.032	0.233	5.0
W	0.070	0.026	0.184	4.3
WNW	0.086	0.027	0.207	4.4
NW	0.197	0.076	0.475	3.6
NNW	0.216	0.059	0.420	3.5
N	0.314	0.079	0.559	3.1

Table A3.4.6

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 6 GROUND STATION 12

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.199	0.092	0.508	3.4
NE	0.158	0.049	0.351	3.9
ENE	0.268	0.069	0.542	4.0
E	0.158	0.043	0.329	3.9
ESE	0.195	0.051	0.414	4.3
SE	0.132	0.045	0.267	3.0
SSE	0.146	0.059	0.355	3.6
S	0.133	0.049	0.367	4.8
SSW	0.181	0.065	0.369	2.9
SW	0.040	0.028	0.199	5.6
WSW	0.083	0.043	0.277	4.5
W	0.158	0.054	0.324	3.1
WNW	0.069	0.030	0.245	5.9
NW	0.090	0.027	0.227	5.0
NNW	0.097	0.049	0.322	4.5
N	0.130	0.068	0.400	4.0

****
****

Table A3.4.7

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 7 GROUND STATION 59

****
****

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.248	0.111	0.607	3.2
NE	0.165	0.067	0.443	4.1
ENE	0.294	0.095	0.662	3.9
E	0.426	0.093	0.741	3.4
ESE	0.376	0.103	0.686	3.0
SE	0.241	0.081	0.494	3.1
SSE	0.385	0.094	0.684	3.2
S	0.363	0.075	0.616	3.4
SSW	0.269	0.066	0.479	3.2
SW	0.158	0.066	0.514	5.4
WSW	0.122	0.056	0.426	5.4
W	0.136	0.035	0.264	3.6
WNW	0.119	0.048	0.302	3.8
NW	0.065	0.034	0.209	4.3
NNW	0.066	0.029	0.302	8.0
N	0.167	0.066	0.392	3.4

Table A3.4.8

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

HOT WIRE POINT 8 GROUND STATION 14

WIND DIR	VAVE/ VGRAD	VRMS/ VGRAD	VPEAK/ VGRAD	GUST FACTOR
NNE	0.095	0.040	0.305	5.2
NE	0.028	0.030	0.179	5.0
ENE	0.029	0.017	0.098	4.1
E	0.027	0.018	0.086	3.4
ESE	0.035	0.017	0.098	3.6
SE	0.068	0.043	0.257	4.4
SSE	0.156	0.063	0.373	3.5
S	0.102	0.038	0.300	5.2
SSW	0.099	0.041	0.308	5.0
SW	0.074	0.035	0.239	4.8
WSW	0.051	0.037	0.227	4.8
W	0.210	0.061	0.390	3.0
WNW	0.045	0.026	0.226	7.0
NW	0.071	0.040	0.281	5.2
NNW	0.109	0.040	0.247	3.5
N	0.081	0.040	0.237	3.9

Table A4.1.1

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% AVERAGE VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	80	12	45	29	0	1	0	0	0	1	1	0	0	1	3	2	3
2	73	0	56	27	3	0	0	0	8	4	0	0	0	1	2	0	0
3	66	0	17	35	16	2	0	0	0	0	0	0	7	11	2	0	0
4	61	0	29	21	15	2	0	0	0	28	4	0	0	0	0	0	0
5	59	1	58	34	6	0	0	0	1	0	0	0	0	0	0	0	0
6	12	0	6	9	1	0	0	0	0	0	0	0	[illegible]	74	2	0	0
7	11	0	8	6	0	0	0	0	0	0	86	0	0	0	0	0	0
8	110	2	0	0	0	0	0	0	0	0	0	0	0	1	3	12	81
9	28	8	2	0	1	0	0	0	0	70	0	0	0	0	1	0	17
10	26	2	2	0	0	0	0	0	2	8	0	0	0	[illegible]	28	0	0
11	7	0	0	0	5	0	0	0	5	86	1	0	1	0	0	0	0
12	9	0	0	1	0	0	0	0	0	61	33	0	0	4	0	0	0
13	48	0	0	0	0	0	0	0	7	83	8	0	0	0	0	0	0
14	53	2	6	4	1	0	0	0	18	66	3	0	0	0	0	0	0
15	52	11	13	3	0	0	0	0	0	3	0	0	0	55	13	0	0
16	43	0	0	0	0	0	0	0	0	20	59	1	13	0	0	0	1
17	39	0	1	2	15	5	0	0	0	18	59	0	0	0	0	0	0
18	5	11	16	3	8	2	0	0	0	55	6	0	0	0	0	0	0
19	3	1	0	0	1	10	0	0	0	28	54	0	0	0	6	0	0
20	1	0	0	1	1	0	1	0	0	6	91	0	0	0	0	0	0
21	31	0	0	1	4	0	0	0	0	0	0	0	0	33	61	0	0
22	33	24	6	0	0	0	0	0	0	0	0	0	5	17	41	2	5
23	22	0	1	0	1	0	0	0	0	0	0	0	0	46	52	0	0
24	24	0	0	0	1	0	0	0	0	0	3	0	0	3	93	0	0
25	111	0	0	7	16	13	0	0	0	0	0	0	35	28	0	1	0
26	19	0	0	1	0	5	0	0	0	26	0	0	3	51	12	0	0
27	14	0	0	0	0	0	0	0	0	0	0	0	15	77	8	0	0
28	15	0	0	2	1	1	0	0	14	0	0	0	4	65	10	0	0
29	17	0	9	0	0	0	0	0	0	73	3	0	0	15	0	0	0
30	94	0	0	0	6	4	0	0	17	16	0	0	0	[illegible]	54	1	1
31	87	10	10	11	0	0	0	1	14	50	3	0	0	[illegible]	0	0	1
32	104	0	2	13	11	0	0	2	0	0	2	0	0	33	31	0	0

****

Table A4.1.2

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% EFFECTIVE PEAK VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

****

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	80	11	42	30	0	1	0	0	0	1	1	0	3	7	2	1	1
2	73	1	41	27	4	0	0	0	5	19	0	0	0	0	1	0	0
3	66	1	20	32	28	1	0	0	0	0	0	0	4	10	3	0	0
4	62	1	30	22	15	3	0	0	0	21	6	0	0	0	0	0	0
5	59	6	52	32	7	1	0	0	1	1	0	0	0	0	0	0	0
6	12	2	9	11	1	0	0	0	0	0	0	0	11	61	4	0	1
7	11	1	9	10	1	0	0	0	0	3	76	0	0	0	0	0	0
8	110	1	1	0	0	0	0	0	0	6	0	0	0	11	23	8	51
9	28	7	3	0	1	0	0	0	0	70	0	0	0	1	1	0	17
10	26	2	4	0	0	0	0	0	2	20	0	0	0	54	17	1	0
11	7	0	2	1	7	0	0	0	4	71	8	0	4	2	1	0	0
12	9	0	1	1	0	0	0	0	0	63	30	0	0	4	0	0	0
13	48	0	1	1	1	0	0	0	15	72	10	0	0	0	0	0	0
14	53	3	5	5	2	0	0	1	19	61	4	0	0	0	0	0	0
15	52	6	9	3	1	0	0	0	0	5	0	0	0	61	15	0	0
16	43	0	0	0	0	0	0	0	0	20	59	1	9	2	0	0	10
17	39	0	2	1	14	5	0	0	0	36	42	0	0	0	0	0	0
18	5	18	15	2	5	1	0	0	0	53	6	0	0	0	0	0	0
19	3	2	1	0	3	3	0	0	0	32	47	0	0	0	11	0	0
20	1	0	1	1	2	1	1	0	0	19	74	0	0	0	0	0	0
21	31	0	0	2	4	0	0	0	1	1	0	0	1	38	51	1	0
22	33	15	5	0	0	0	0	0	0	0	0	0	4	14	53	4	4
23	22	0	4	0	2	0	0	0	0	0	0	0	0	41	53	0	0
24	24	0	0	0	1	0	0	0	0	0	3	0	0	4	91	0	0
25	111	0	0	7	10	4	0	0	0	0	0	0	45	30	0	3	0
26	19	0	0	3	1	4	0	0	6	34	0	0	2	33	17	0	0
27	14	0	0	0	0	0	0	0	0	0	0	0	12	72	10	0	0
28	15	0	2	2	1	0	0	0	7	0	0	0	14	61	12	0	0
29	17	1	9	0	0	1	0	0	0	59	1	0	0	29	1	0	0
30	94	0	0	0	17	4	0	0	13	22	0	0	0	1	39	3	1
31	87	9	12	18	0	0	0	1	11	41	7	0	0	0	0	0	2
32	104	0	7	20	11	0	0	2	0	0	14	0	0	22	22	0	0

Table A4.1.3

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TWIN TOWERS SEPARATED BY 60 FEET - NO TREES DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% PEAK VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	80	8	37	23	0	1	0	0	0	5	3	1	6	11	4	1	2
2	73	5	32	18	3	0	0	0	5	28	3	0	3	1	1	0	0
3	66	4	17	26	32	1	0	0	0	0	1	0	3	12	4	0	0
4	62	3	25	22	17	4	0	0	1	17	10	0	1	1	0	0	0
5	59	10	45	26	6	2	0	0	1	8	0	0	0	1	1	0	0
6	12	4	10	15	2	0	0	0	0	2	1	0	11	47	5	0	3
7	11	5	9	9	2	0	0	0	0	34	42	0	0	0	0	0	0
8	110	2	1	0	0	0	0	0	0	19	1	0	0	15	24	3	34
9	23	7	4	0	0	0	0	0	0	57	0	0	0	4	2	0	26
10	26	4	3	0	0	0	0	0	2	21	0	0	2	41	20	2	0
11	7	1	12	2	10	0	0	0	2	52	8	0	5	6	2	0	1
12	9	0	5	4	2	0	0	0	0	49	32	0	2	5	1	0	0
13	48	1	3	14	5	0	0	0	10	56	11	0	0	0	0	0	0
14	53	6	6	12	7	0	0	2	17	37	12	0	0	1	0	0	0
15	52	3	12	3	1	0	0	0	0	9	0	0	1	45	25	0	0
16	43	0	0	0	0	0	0	0	0	8	36	2	7	5	4	1	38
17	39	0	4	1	23	4	0	0	0	42	25	0	0	0	0	0	0
18	5	21	13	3	8	1	0	0	0	46	7	0	0	0	0	0	0
19	3	6	6	1	6	1	0	0	0	23	48	0	0	1	7	0	0
20	1	2	9	1	7	3	0	0	0	32	42	0	0	1	1	1	1
21	31	0	0	2	2	0	0	0	3	3	1	0	0	50	37	2	0
22	33	12	6	1	0	0	0	0	0	1	1	0	2	10	55	9	2
23	22	2	10	2	3	0	0	0	0	0	0	0	0	31	51	0	0
24	24	1	1	0	2	0	0	0	0	0	5	0	0	12	78	1	0
25	111	0	1	3	6	1	0	0	0	0	0	0	37	46	0	6	0
26	19	0	0	6	1	3	0	0	16	23	0	0	4	27	19	0	0
27	14	0	1	1	1	0	0	0	0	0	0	0	17	71	10	0	0
28	15	1	7	2	1	1	0	0	6	0	0	0	23	47	12	0	0
29	17	2	15	1	0	1	0	1	2	35	0	0	1	36	5	0	0
30	94	0	0	3	17	4	0	0	9	13	0	0	0	1	44	6	2
31	87	8	13	22	0	0	0	0	7	38	8	0	0	0	0	0	3
32	104	3	9	17	11	1	0	2	0	3	25	0	0	13	16	0	1

Table A4.2.1

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% AVERAGE VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	11	58	10	0	0	0	0	0	0	0	0	0	0	0	5	1	25
2	12	0	26	8	11	23	0	0	0	1	0	0	0	30	0	0	0
3	61	0	34	24	10	1	0	0	0	26	5	0	0	0	0	0	0
4	66	0	32	32	14	2	0	0	0	0	0	0	4	10	5	0	0
5	80	12	77	0	0	0	0	0	0	0	2	0	8	0	0	0	0
6	73	0	26	17	1	0	0	0	19	20	0	0	9	2	5	0	0
7	59	3	59	34	4	0	0	0	0	0	0	0	0	0	0	0	0
8	14	0	0	0	0	0	0	0	0	0	0	0	3	0	97	0	0

****

Table A4.2.2

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% EFFECTIVE PEAK VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

****

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	11	41	14	0	0	0	0	0	0	0	0	0	0	0	28	1	16
2	12	3	39	12	11	11	0	0	0	8	0	0	0	16	0	0	0
3	62	0	35	22	11	3	0	0	1	19	9	0	0	0	0	0	0
4	66	1	28	28	13	2	0	0	0	0	0	0	4	13	10	0	0
5	80	18	67	0	0	0	0	0	0	0	3	0	9	2	0	0	0
6	73	0	22	13	3	0	0	0	14	29	0	0	13	1	[illegible]	0	0
7	59	7	58	30	3	0	0	0	0	0	0	0	0	0	1	0	0
8	14	0	0	0	0	[illegible]	0	0	0	0	0	[illegible]	12	0	87	0	0

****

Table A4.2.3

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 1 - TOWERS SEPARATED BY 60 FEET DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% PEAK VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

****

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	11	33	10	0	0	0	0	0	0	0	0	0	0	0	49	0	7
2	12	10	43	23	9	4	0	0	0	6	1	0	0	3	[illegible]	1	0
3	61	1	27	15	11	5	0	0	1	14	17	0	1	2	2	0	0
4	66	3	21	24	14	1	0	0	[illegible]	0	3	0	4	15	11	0	0
5	80	16	57	1	0	0	0	0	0	0	6	1	8	10	0	0	1
6	73	2	16	9	3	0	0	0	6	19	4	1	30	6	3	0	0
7	59	6	57	25	4	1	0	0	0	0	1	0	0	0	2	0	0
8	14	0	0	0	2	0	0	0	1	0	0	0	13	1	81	0	0

****
****

Table A4.3.1

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT   PHASE III
TREE CONFIGURATION 2 - TOWERS SEPARATED BY 60 FEET   DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% AVERAGE VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

****
****

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	61	1	26	16	16	1	0	0	1	29	8	0	0	0	0	0	0
2	55	0	25	21	19	2	1	0	0	0	0	0	8	16	10	0	0
3	9	0	21	22	21	1	0	0	2	11	16	0	1	5	0	0	0
4	58	0	0	8	4	0	0	0	0	0	88	0	0	0	0	0	0
5	11	43	0	0	0	0	0	0	0	0	0	0	0	0	9	2	46
6	12	1	98	1	0	0	0	0	0	0	0	0	0	0	0	0	0
7	59	26	45	6	20	1	0	0	1	0	0	0	0	0	0	0	0
8	14	1	0	0	0	0	0	0	0	0	0	0	99	0	0	0	0

Table A4.3.2

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 2 - TOWERS SEPARATED BY 60 FEET DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% EFFECTIVE PEAK VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	62	3	26	16	16	1	0	0	4	23	9	0	0	1	0	0	0
2	66	0	24	16	18	2	0	0	0	1	0	0	6	15	17	0	0
3	9	0	15	11	16	1	0	0	2	20	20	0	2	11	0	0	0
4	58	0	2	14	5	0	0	1	1	0	76	0	0	0	0	0	0
5	11	39	0	0	0	0	0	0	0	1	0	0	0	0	22	2	36
6	12	4	93	2	0	0	0	0	0	1	0	0	0	0	0	0	0
7	59	36	43	7	13	1	0	0	0	0	0	0	0	0	0	0	0
8	14	4	0	0	0	0	0	0	0	0	0	0	95	1	0	0	0

Table A4.3.3

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT   PHASE III
TREE CONFIGURATION 2 - TOWERS SEPARATED BY 60 FEET   DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% PEAK VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	62	9	22	16	15	1	0	0	3	20	11	0	1	1	0	0	0
2	66	6	18	11	16	1	0	0	0	2	5	1	4	17	14	0	0
3	9	1	11	7	16	0	0	0	1	14	6	0	3	38	1	0	0
4	58	1	9	15	8	0	0	1	1	2	63	1	0	1	0	0	0
5	11	30	0	0	0	0	0	0	0	9	0	0	0	0	40	0	21
6	12	10	84	4	1	0	0	0	0	1	0	0	1	0	0	0	0
7	59	33	41	11	12	1	0	0	0	0	1	1	1	0	0	0	0
8	14	17	0	0	0	0	0	1	0	2	0	0	71	0	7	0	0

Table A4.4.1

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% AVERAGE VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	61	0	13	5	21	2	0	0	1	39	14	0	0	0	0	[illegible]	0
2	66	0	33	23	16	1	0	0	0	0	0	0	6	12	8	0	0
3	9	0	16	13	24	1	0	0	3	13	21	0	1	6	0	0	0
4	58	0	2	0	4	0	0	0	0	0	93	0	0	0	0	0	0
5	11	29	13	0	0	0	0	0	0	0	0	0	0	0	[illegible]	2	46
6	12	13	7	67	2	1	0	0	0	8	0	0	1	0	0	0	0
7	59	1	0	14	55	11	0	1	11	4	0	0	0	0	0	0	0
8	14	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0

****
****

Table A4.4.2

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% EFFECTIVE PEAK VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

****
****

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	62	0	22	6	19	2	0	0	6	30	14	0	0	1	0	0	0
2	66	2	31	24	15	1	0	0	0	1	0	0	4	11	12	0	0
3	9	0	11	6	20	1	0	0	2	22	23	0	2	14	0	0	0
4	58	0	6	1	7	0	0	1	1	0	84	0	0	1	0	0	0
5	11	24	17	0	0	0	0	0	0	1	0	0	0	0	22	1	36
6	12	26	7	53	1	1	0	0	0	10	0	0	2	0	0	0	0
7	59	9	1	20	46	13	0	2	6	4	0	0	0	0	0	0	0
8	14	0	0	0	0	0	0	1	0	0	0	0	99	0	0	0	0

Table A4.4.3

GROUND WIND HOT WIRE STUDY FOR NEW ENGLAND LIFE PROJECT PHASE III
TREE CONFIGURATION 3 - TOWERS SEPARATED BY 60 FEET DEC 1984

THE PERCENTILE CONTRIBUTIONS OF THE 1% PEAK VELOCITY
FROM EACH WIND DIRECTION FOR EACH GROUND STATION

POINT	STATION	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1	62	1	22	10	18	2	0	0	3	25	15	0	2	2	0	0	0
2	55	6	14	19	15	1	0	0	0	1	5	0	3	12	11	0	0
3	9	1	15	2	16	0	0	0	1	15	7	0	3	39	1	0	0
4	58	3	7	2	10	0	0	1	1	2	72	0	0	1	0	0	0
5	11	18	11	0	0	0	0	0	0	9	0	0	0	0	41	0	21
6	12	30	11	48	2	1	0	0	0	4	0	0	1	0	0	0	2
7	59	13	3	29	39	9	0	1	3	2	0	0	0	0	0	0	0
8	14	5	0	0	0	0	0	2	1	3	0	0	80	0	9	0	0

AUTHOR
500 Boylston Street Project

TITLE

DATE LOANED	BORROWER'S NAME

Appendix 4
Shadow Analysis: Clarendon Street Playgound

500 Boylston Street Project

BRA Final Environmental Impact Report

February 1985

Submitted to	Boston Redevelopment Authority
Project Proponent	A Joint Venture of New England Mutual Life Insurance Company Gerald D. Hines Interests, Inc.
Prepared by	Skidmore, Owings & Merrill Vanasse/Hangen Associates, Inc. Haley & Aldrich, Inc. Tech Environmental Wright Brothers Facility, MIT Historic Preservation Planning & Analysis

Appendix 4
Shadow Analysis: Clarendon Street Playgound

500 Boylston Street Project

BRA Final Environmental Impact Report

February 1985

Submitted to — Boston Redevelopment Authority

Project Proponent — A Joint Venture of
New England Mutual Life Insurance Company
Gerald D. Hines Interests, Inc.

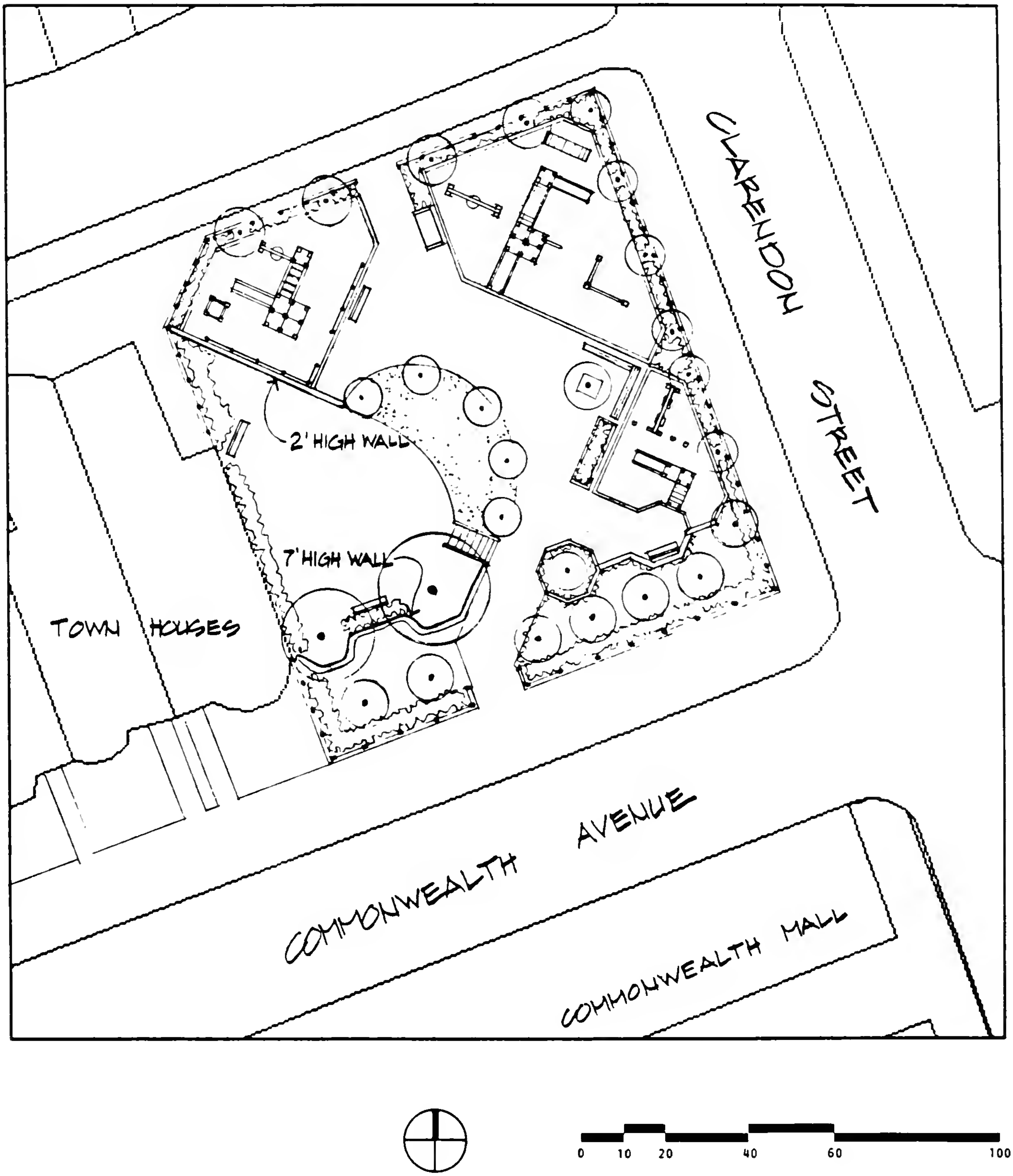
Prepared by — Skidmore, Owings & Merrill
Vanasse/Hangen Associates, Inc.
Haley & Aldrich, Inc.
Tech Environmental
Wright Brothers Facility, MIT
Historic Preservation Planning & Analysis

A computer-generated shadow analysis for the Clarendon Street Playground, located at the northwest corner of Clarendon Street and Commonwealth Avenue, was conducted subsequent to the submission of the BRA Draft EIR in response to concerns raised by the St. James Avenue CAC. The analysis examines the immediate playground area (as shown in the accompanying site plan) at weekly intervals from October 26 to February 15, focusing on the time period from 7:30 AM to 10:00 AM at 15-minute intervals. New shadows cast by the 500 Boylston Street Project and shadows cast by existing building (Hancock tower at Berkeley Street, New England Life building at 501 Boylston, First Baptist Church, 90 Commonwealth Avenue, and so forth) are identified.

The shadow diagrams presented in this Technical Appendix constitute the data upon which the impact assessment in the BRA Final EIR is based. The diagrams indicate shadows cast on the ground plane. The shadow diagrams and the impact assessment do not consider the extensive shadows created by the mature trees on Commonwealth Avenue, nor does it consider shadows created by trees and structures on the playground itself.

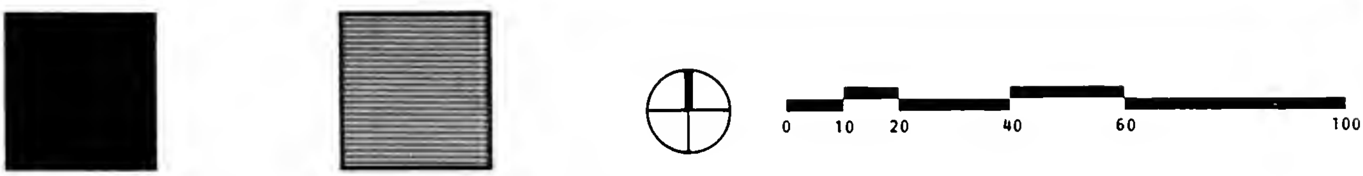
Chapter IV of the BRA Final EIR presents the shadow impact assessment for the Clarendon Street playground and for other areas of the Back Bay, including Copley Square, Commonwealth Avenue Mall, Boylston Street pedestrian and retail area, and the public plazas created by the 500 Boylston Street Project.

Clarendon Street Playground Site Plan



SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

26 October 7:30am



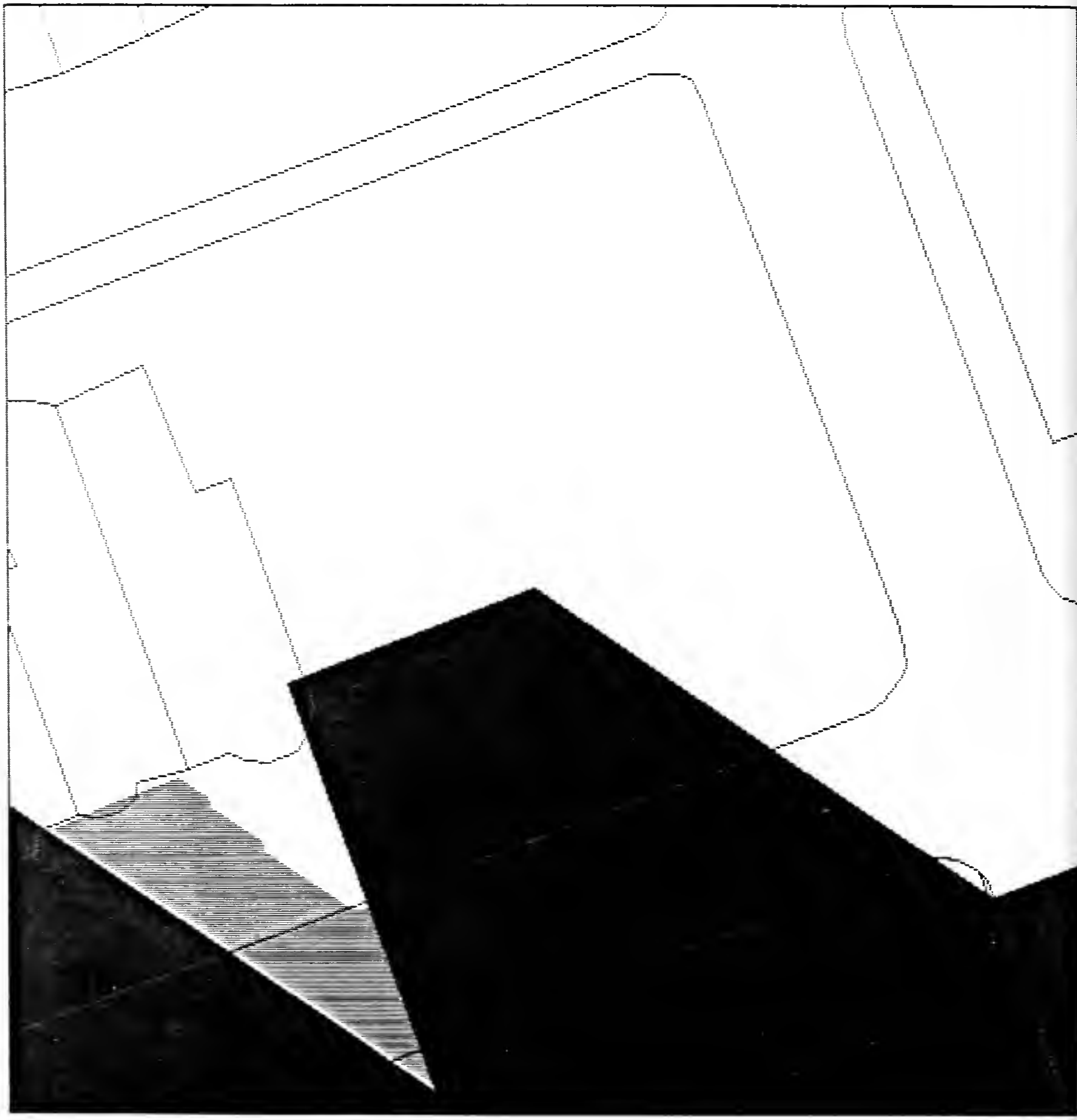
Existing shadow

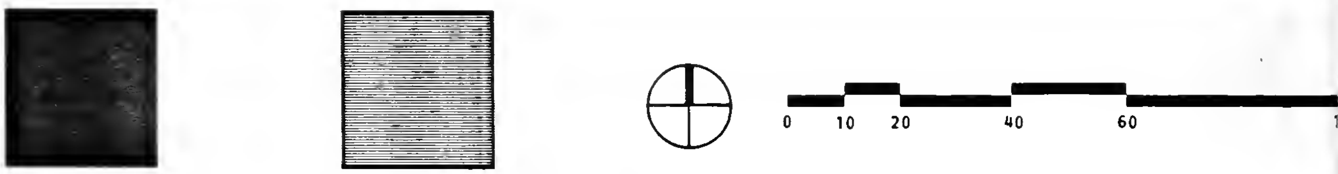
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

26 October 7:45am





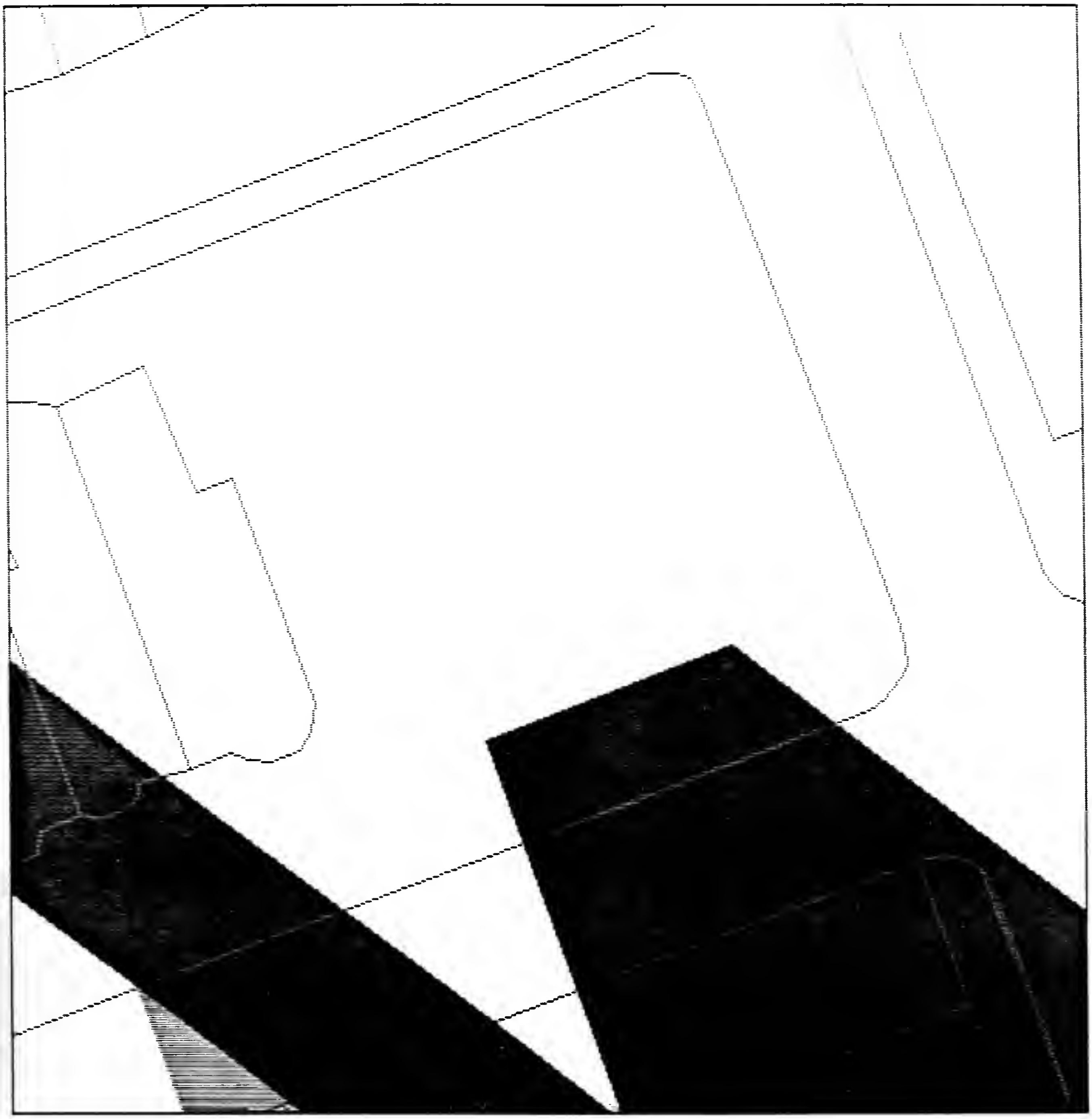
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

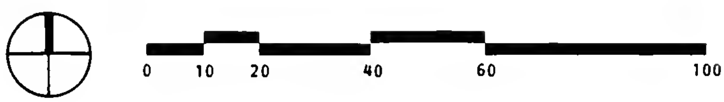
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

26 October 8:00am



Existing shadow

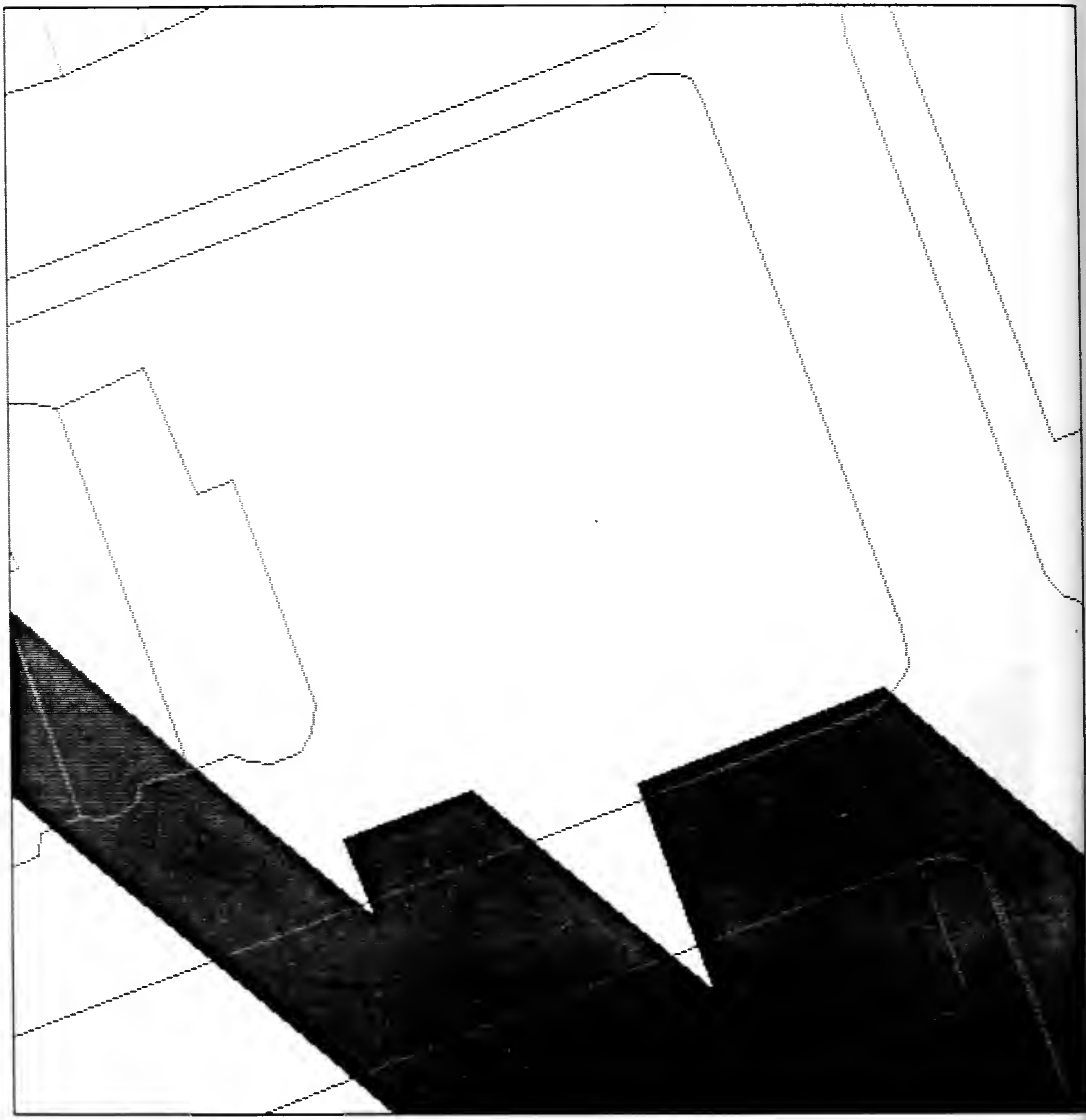
Incremental shadow
New England Life Project

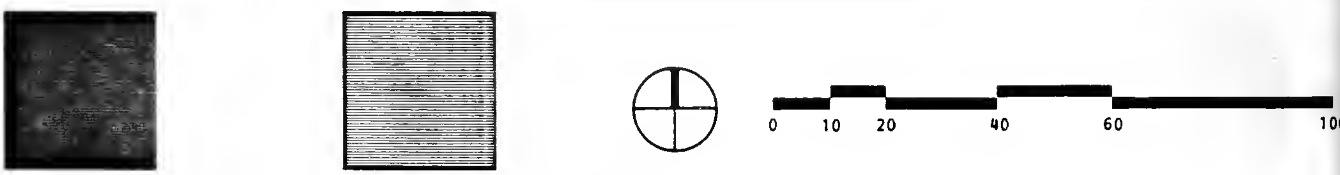


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

26 October 8:15am





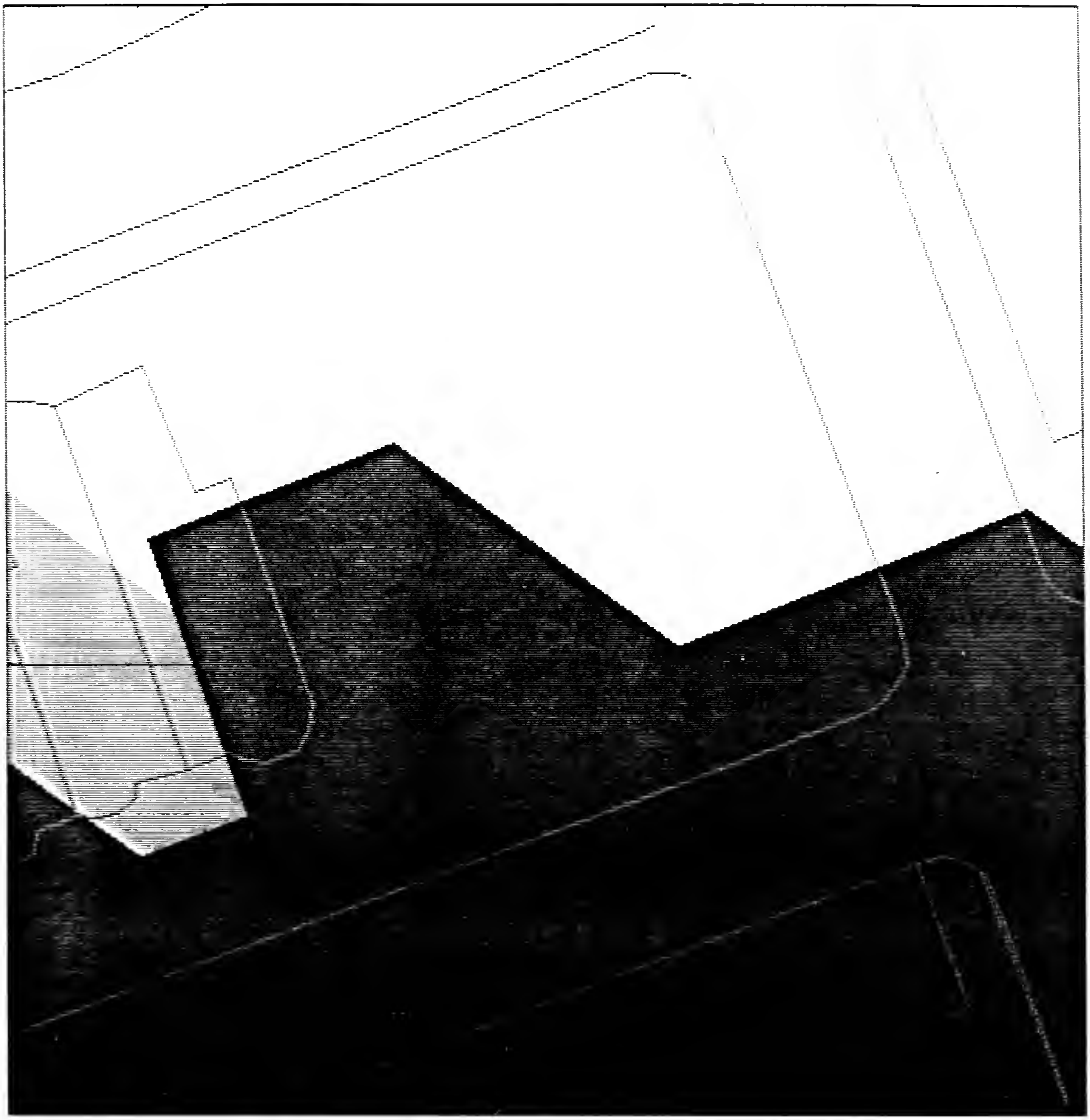
Existing shadow

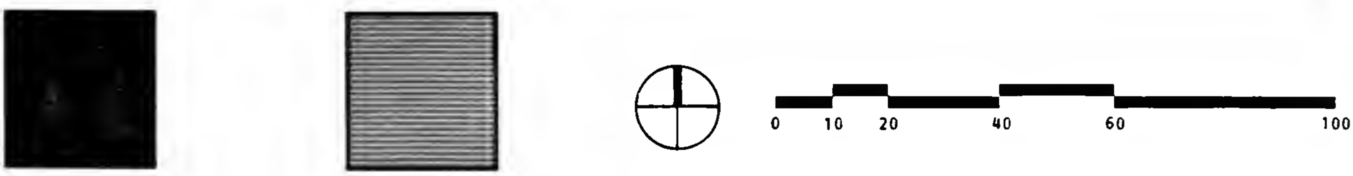
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

2 November 7:45am





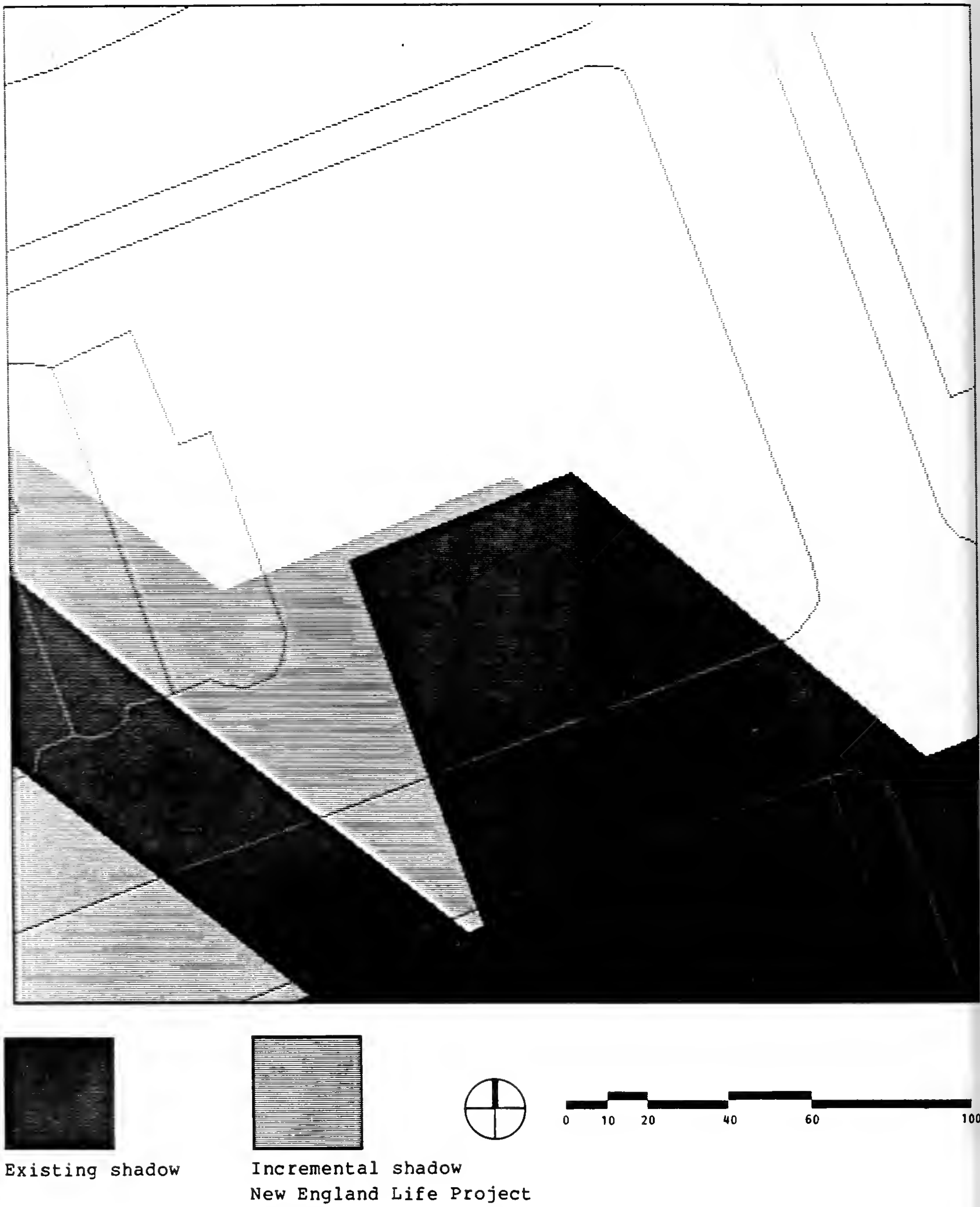
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

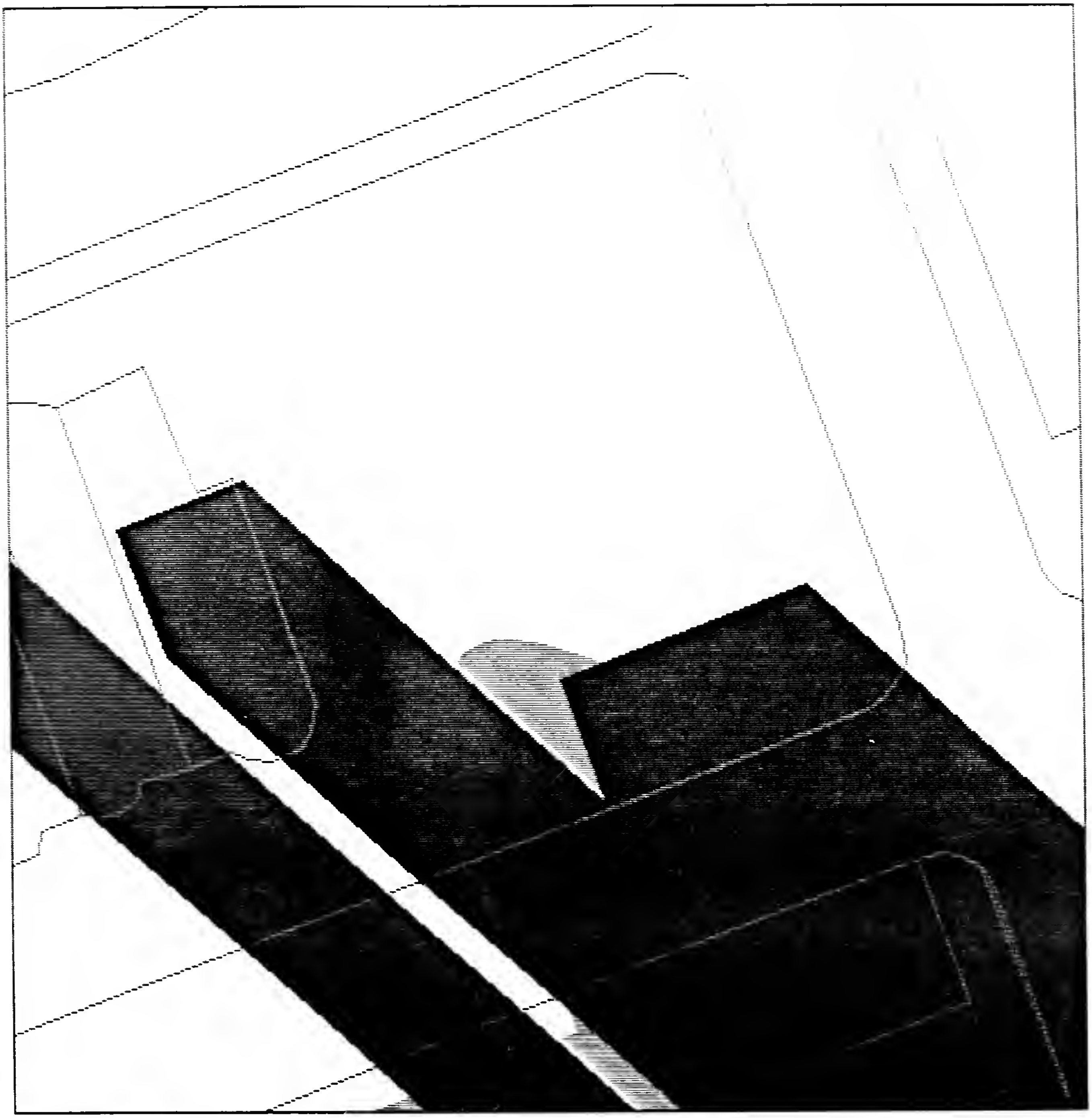
2 November 8:00am

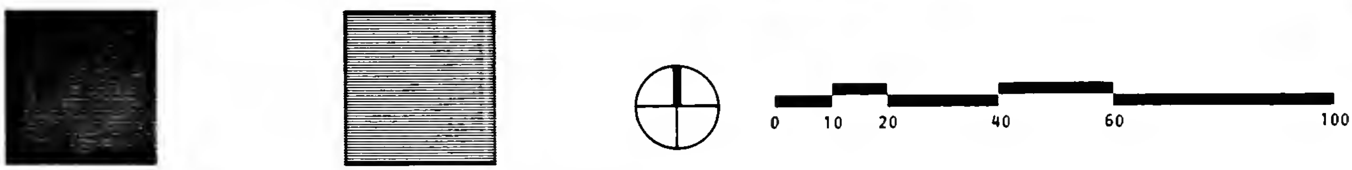


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

2 November 8:15am





Existing shadow

Incremental shadow
New England Life Project

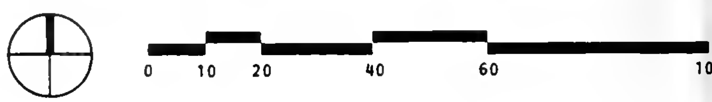
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

2 November 8:30am

Existing shadow

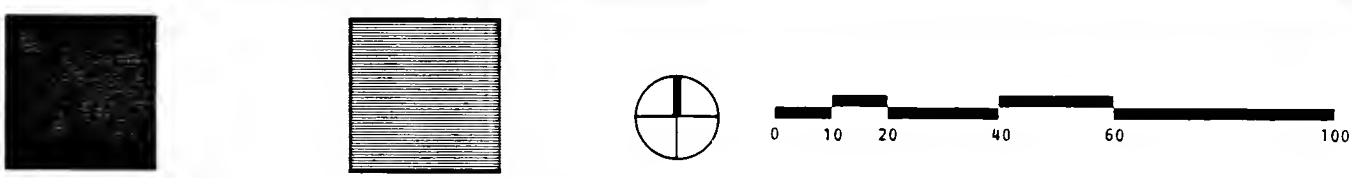
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

9 November 7:45am



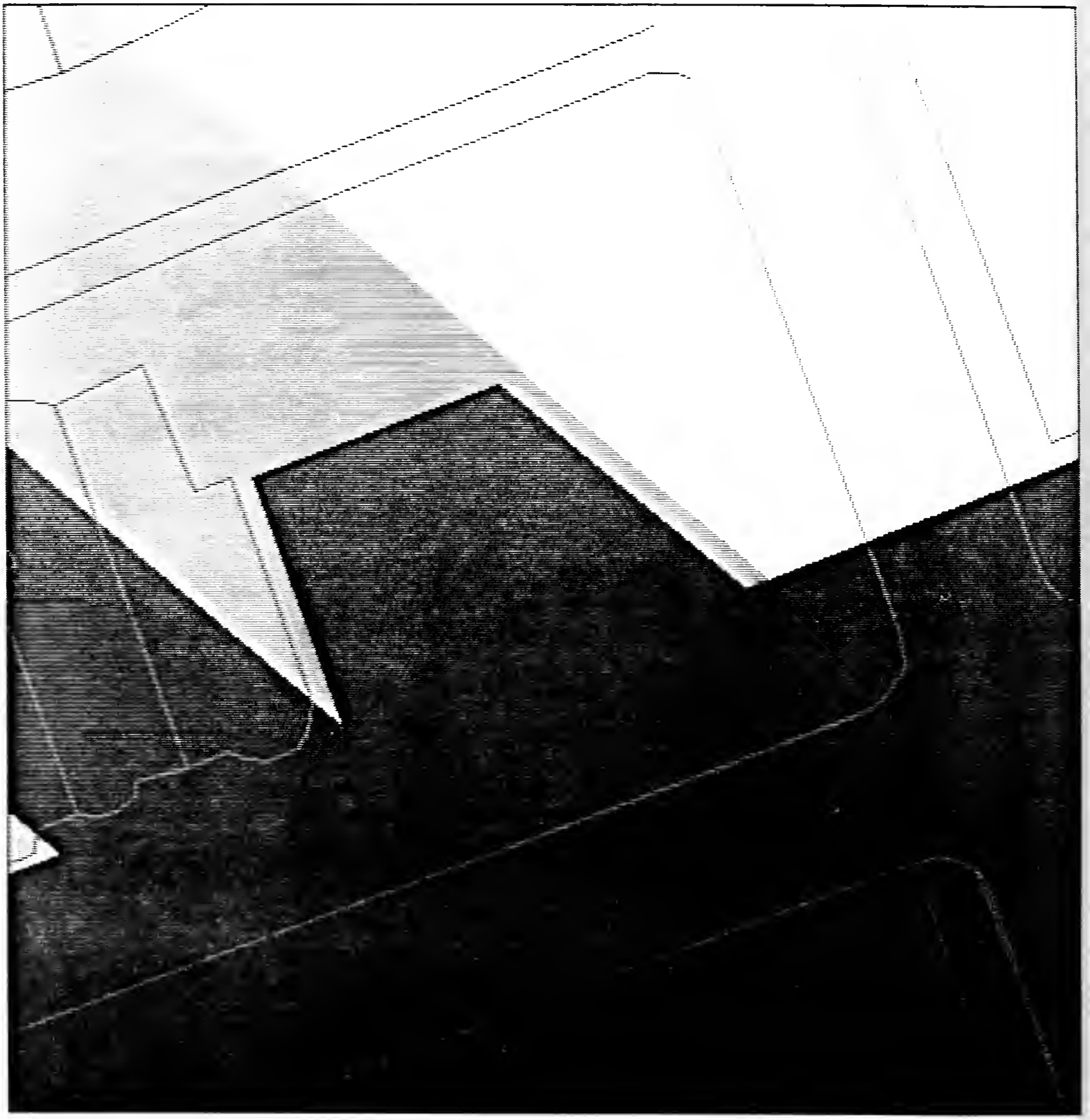
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

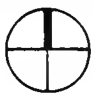
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

9 November 8:00am



Existing shadow

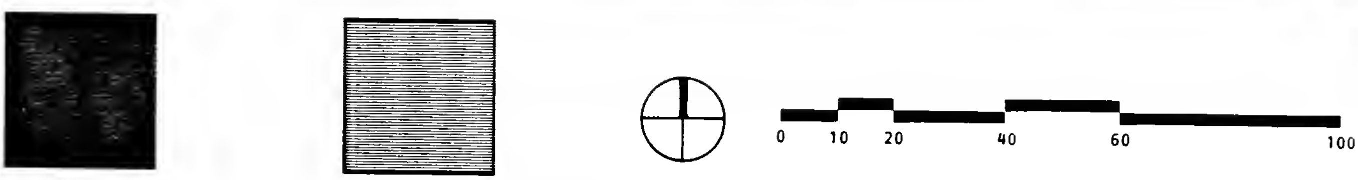
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

9 November 8:15am



Existing shadow

Incremental shadow
New England Life Project

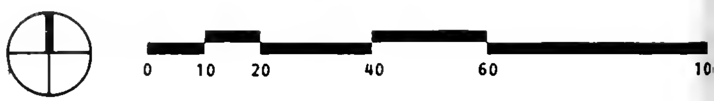
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

9 November 8:30am

Existing shadow

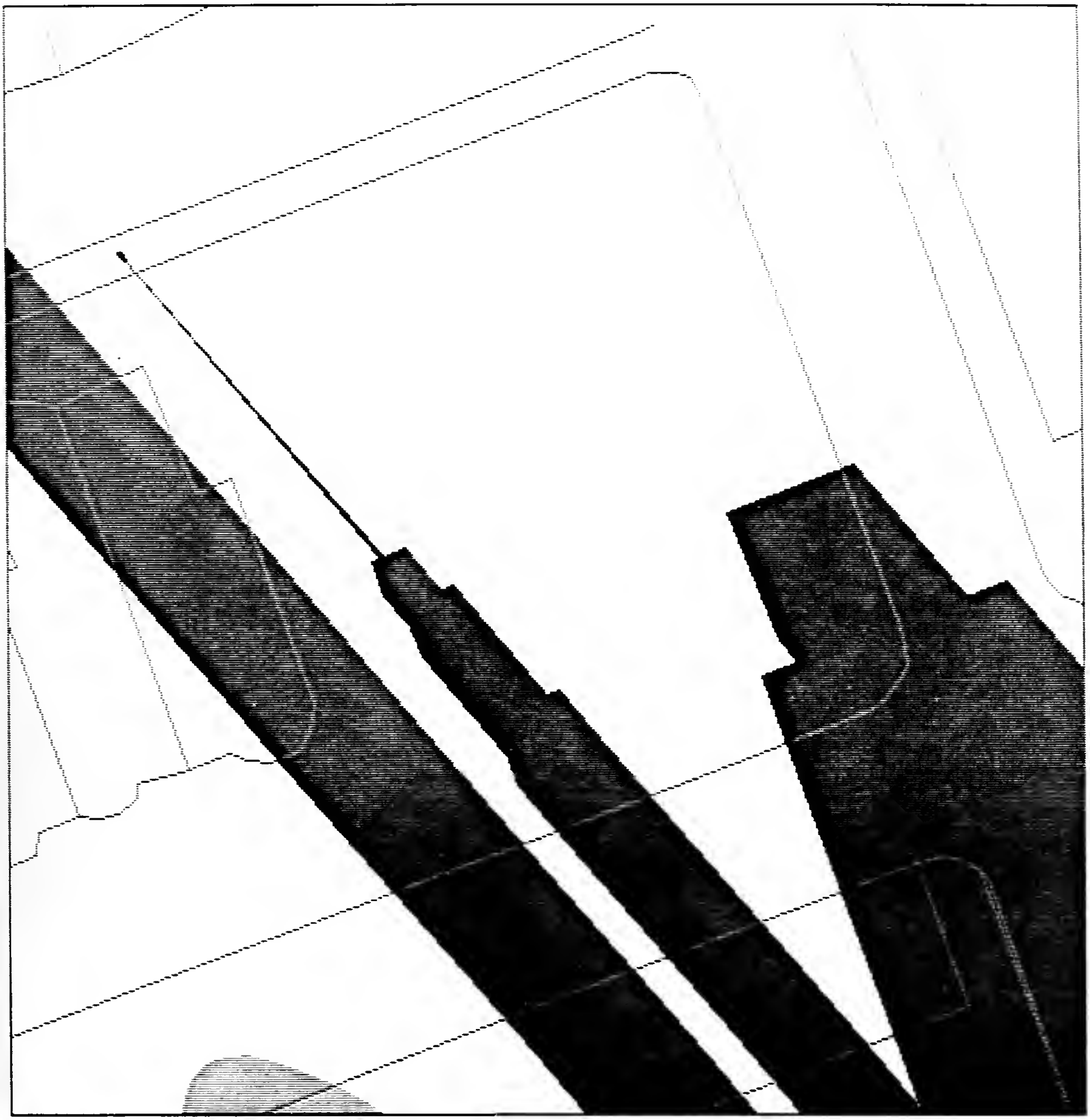
Incremental shadow
New England Life Project

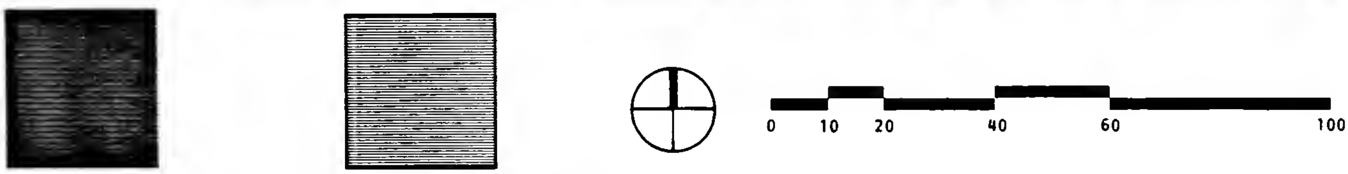


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

9 November 8:45am





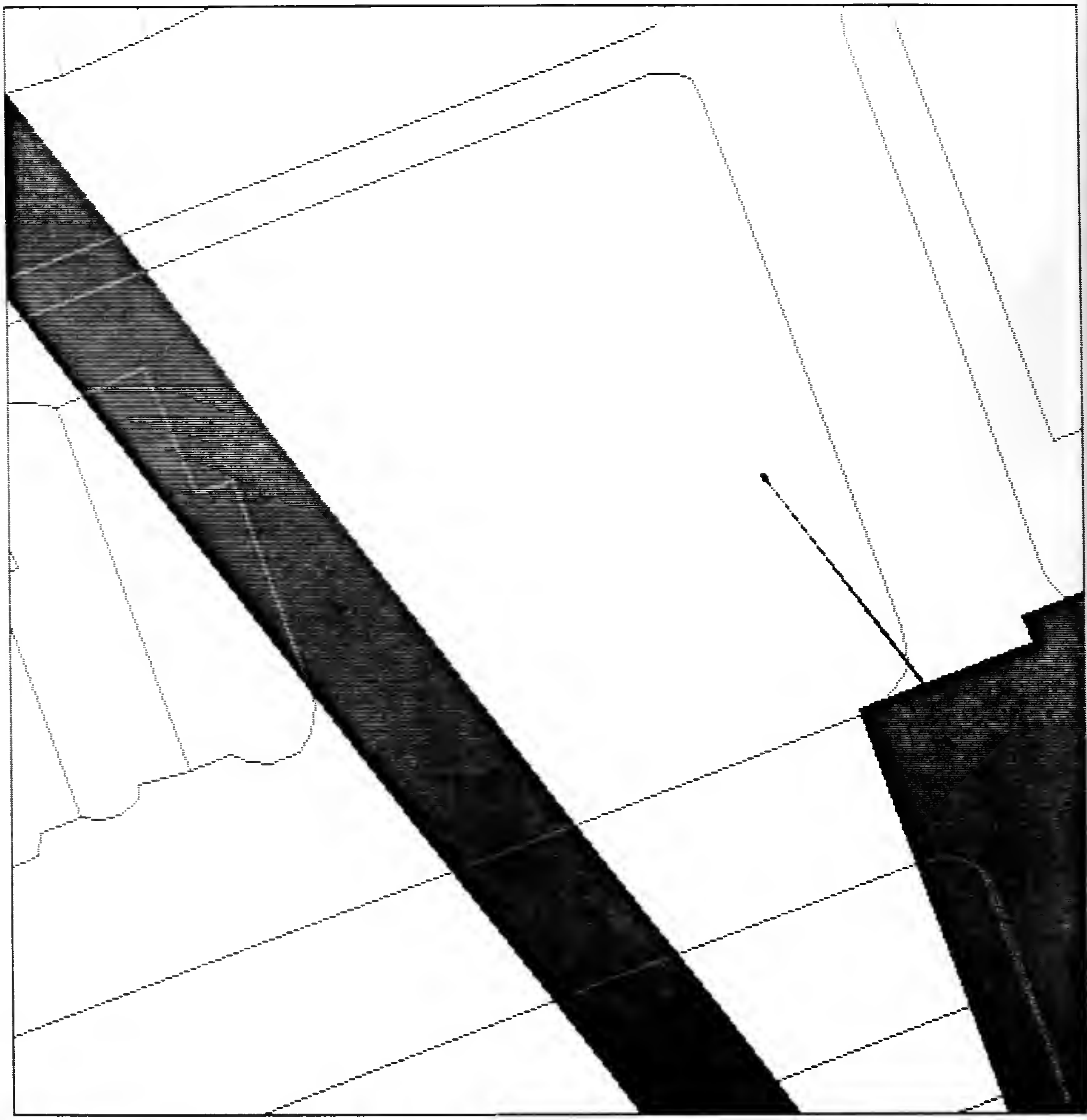
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

9 November 9:00am



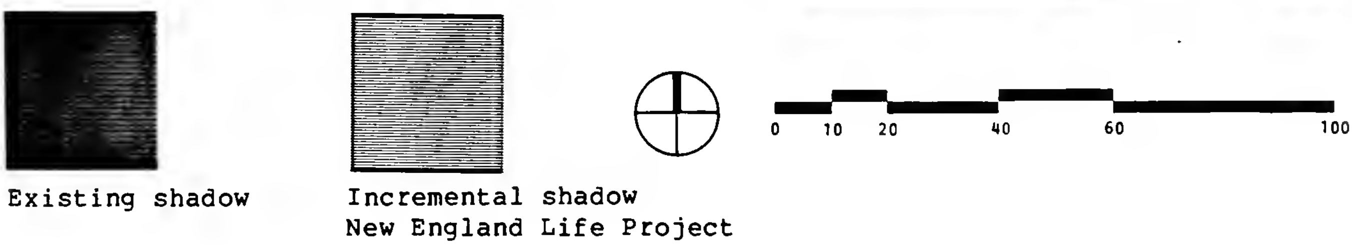
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

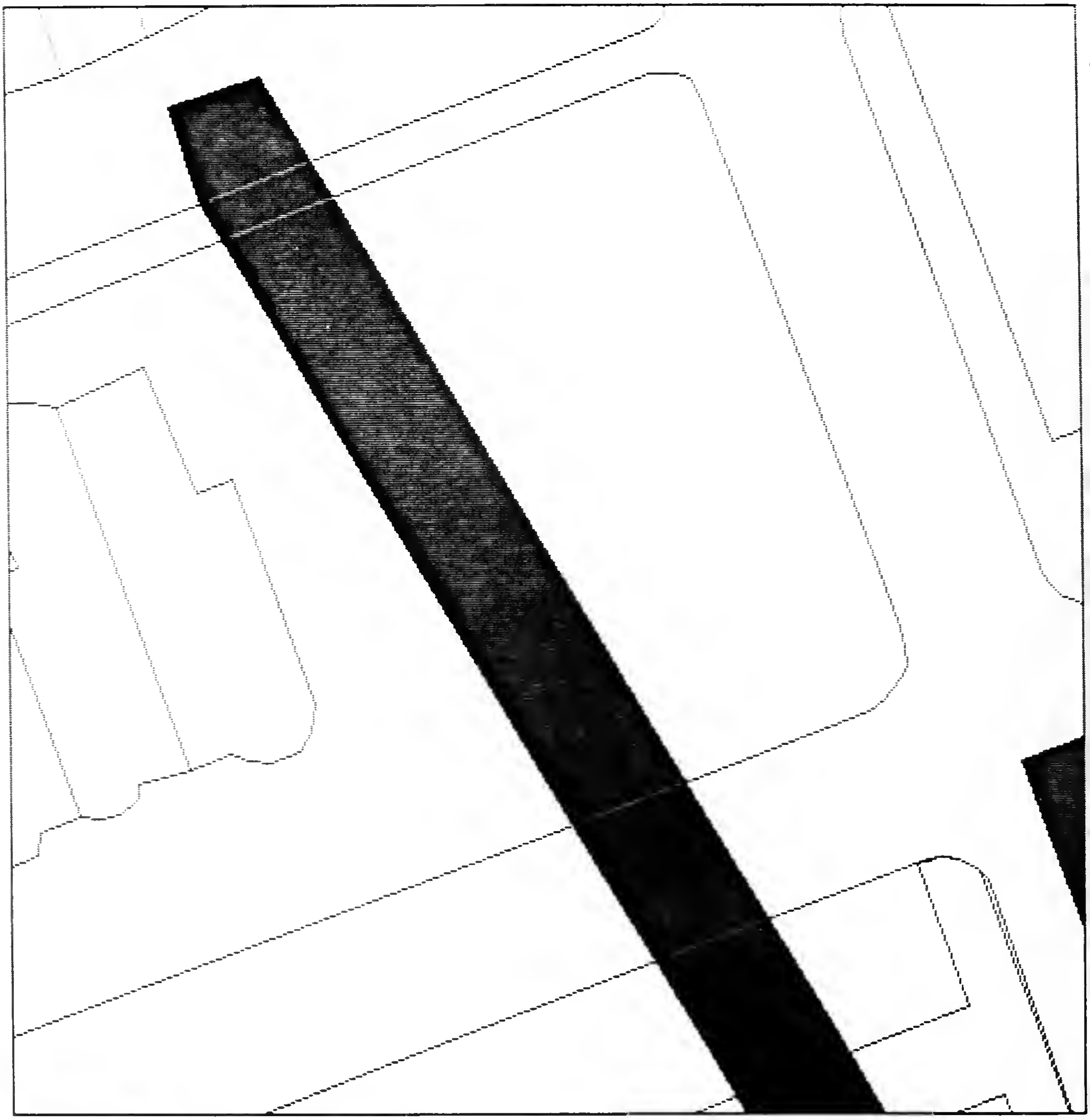
9 November 9:15am

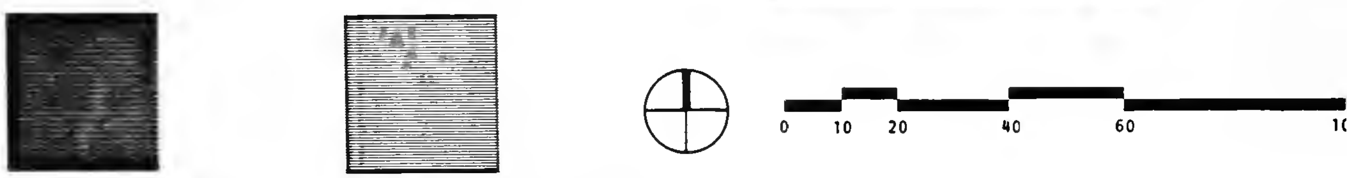


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

9 November 9:30am





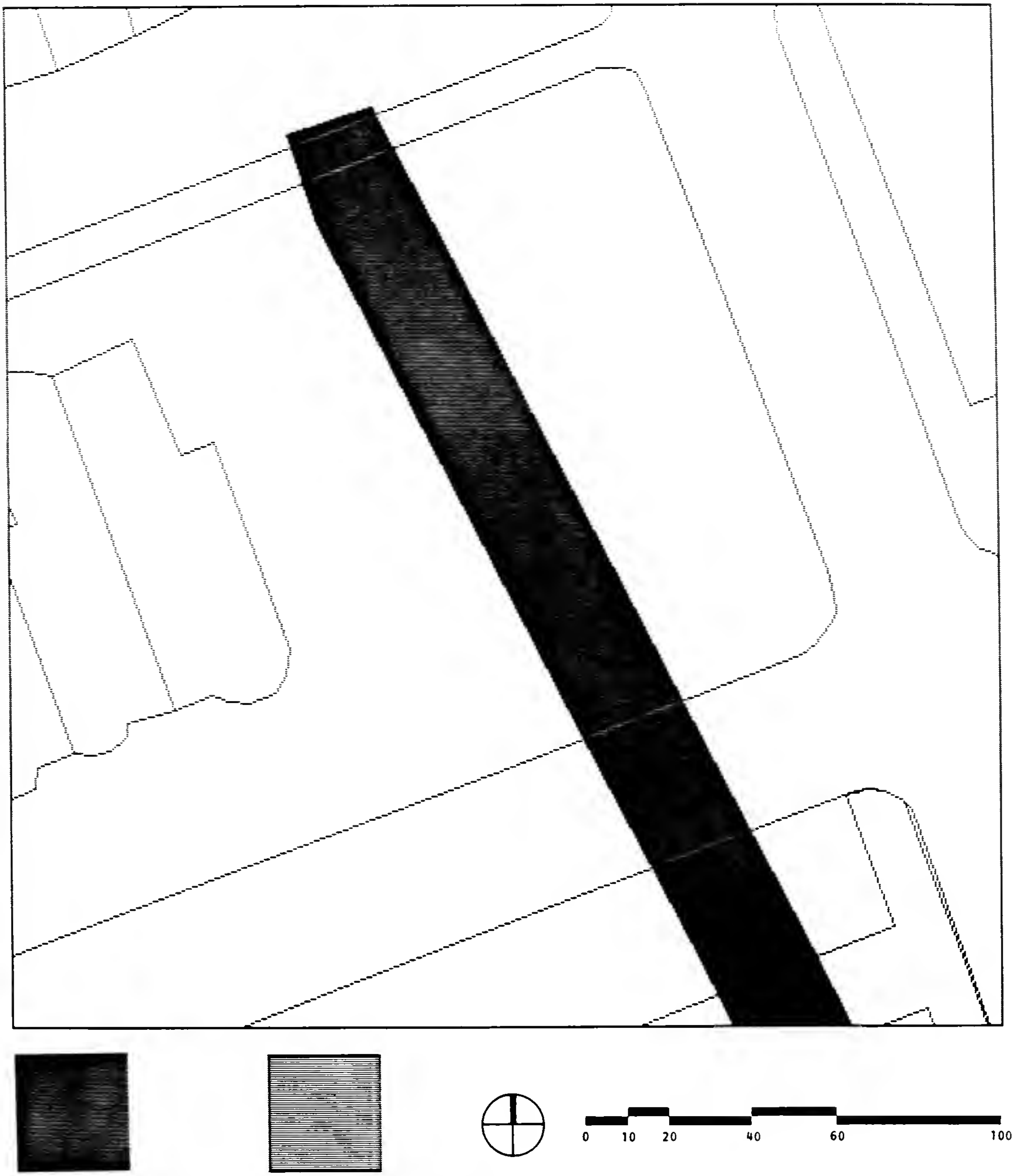
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

9 November 9:45am



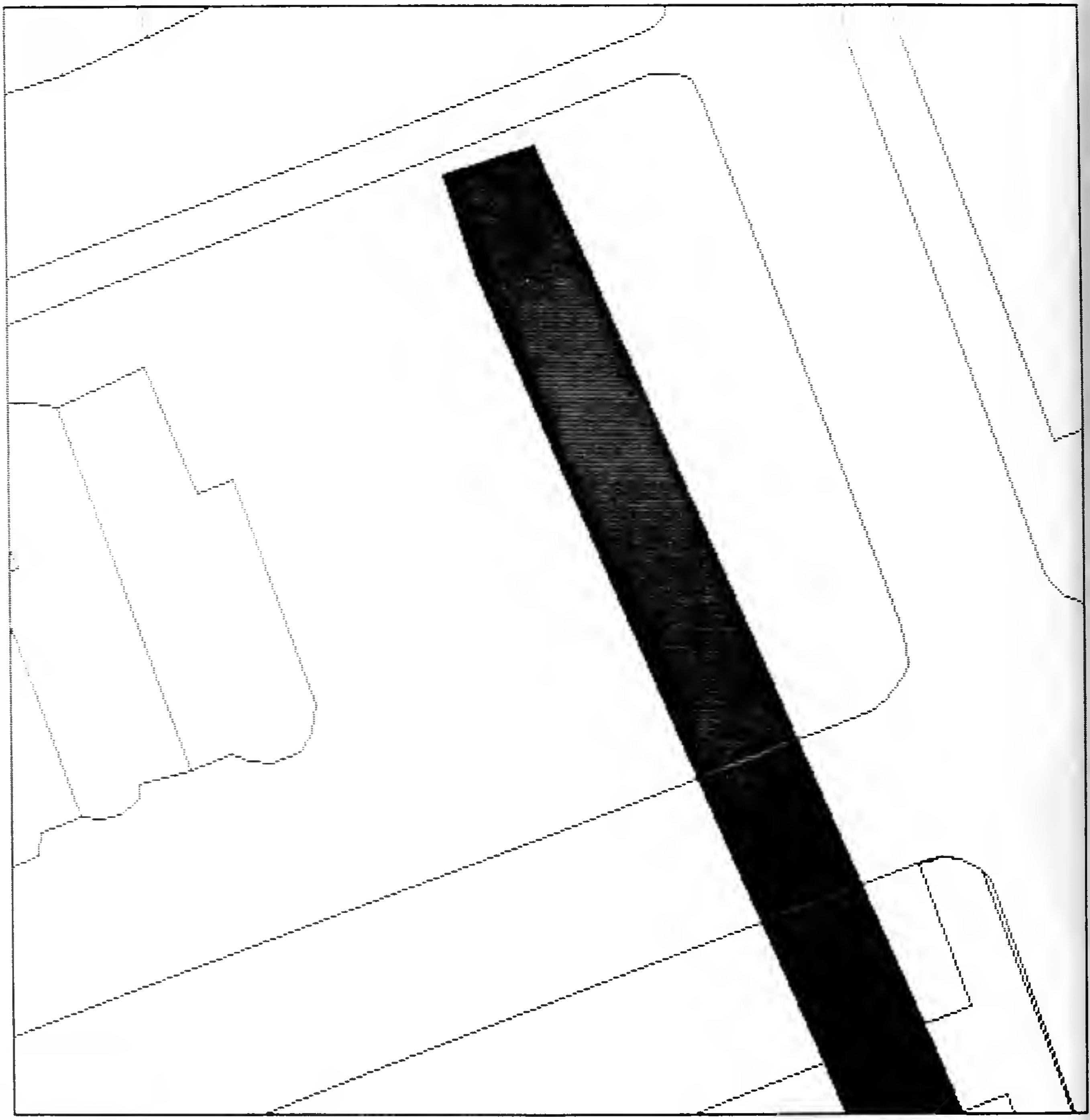
Existing shadow

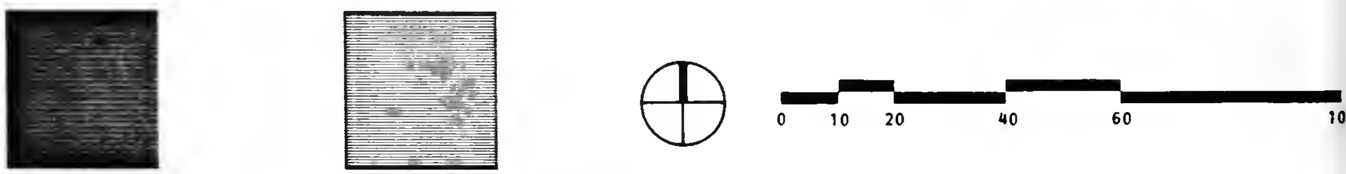
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

9 November 10:00am





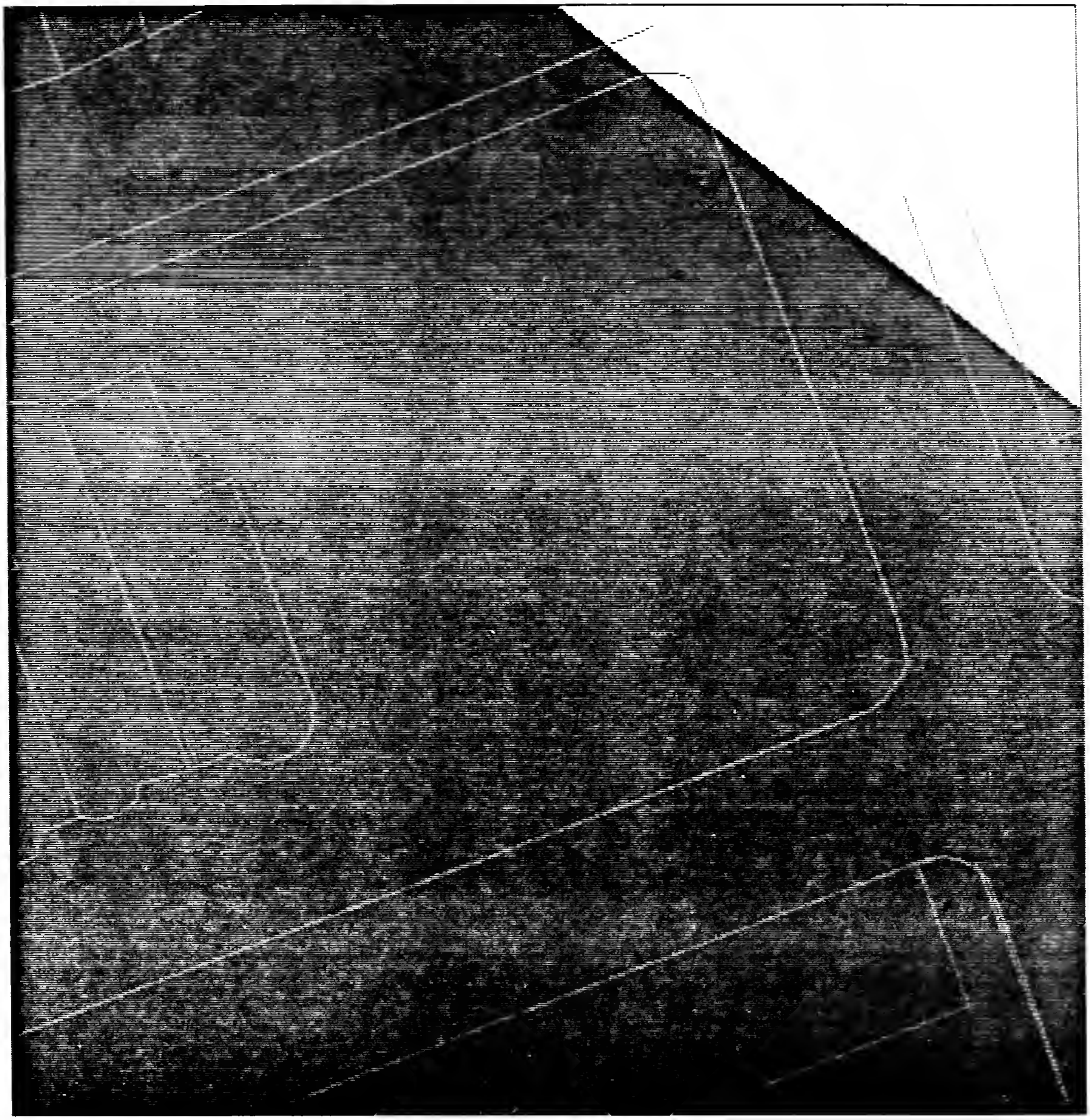
Existing shadow

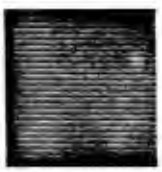
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

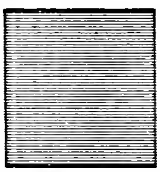
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

16 November 7:45am

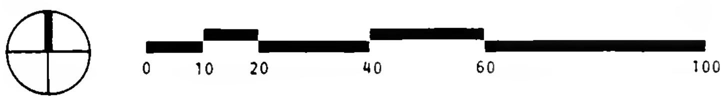




Existing shadow

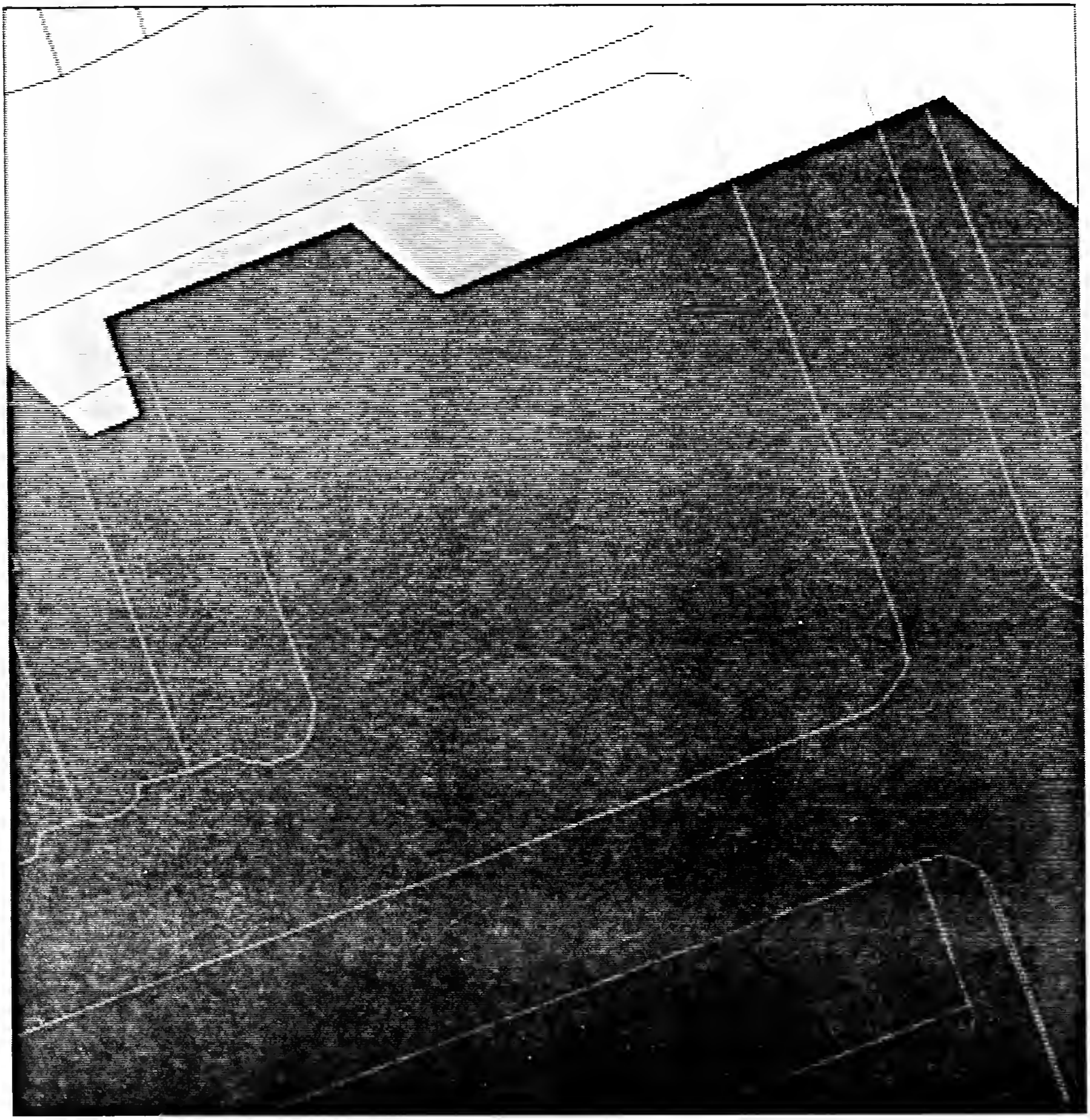


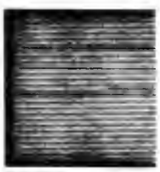
Incremental shadow
New England Life Project



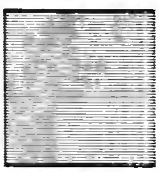
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

16 November 8:00am

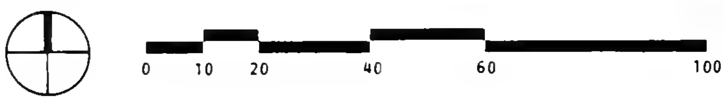




Existing shadow



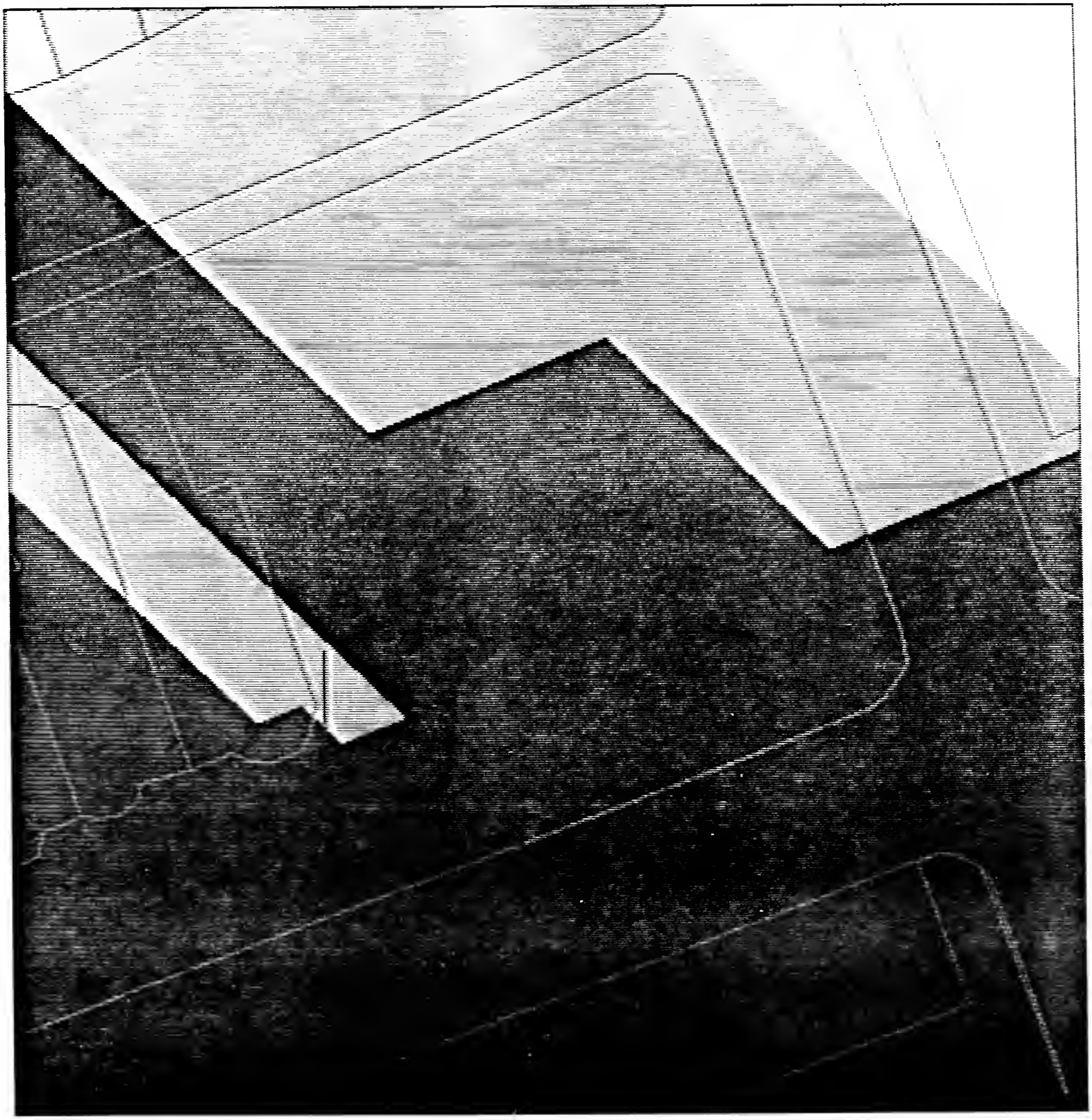
Incremental shadow
New England Life Project

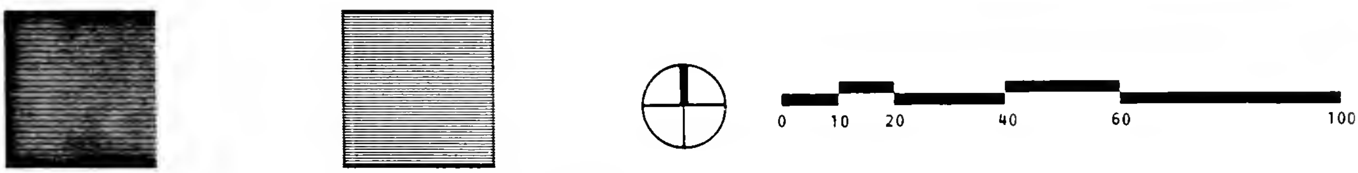


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

16 November 8:15am





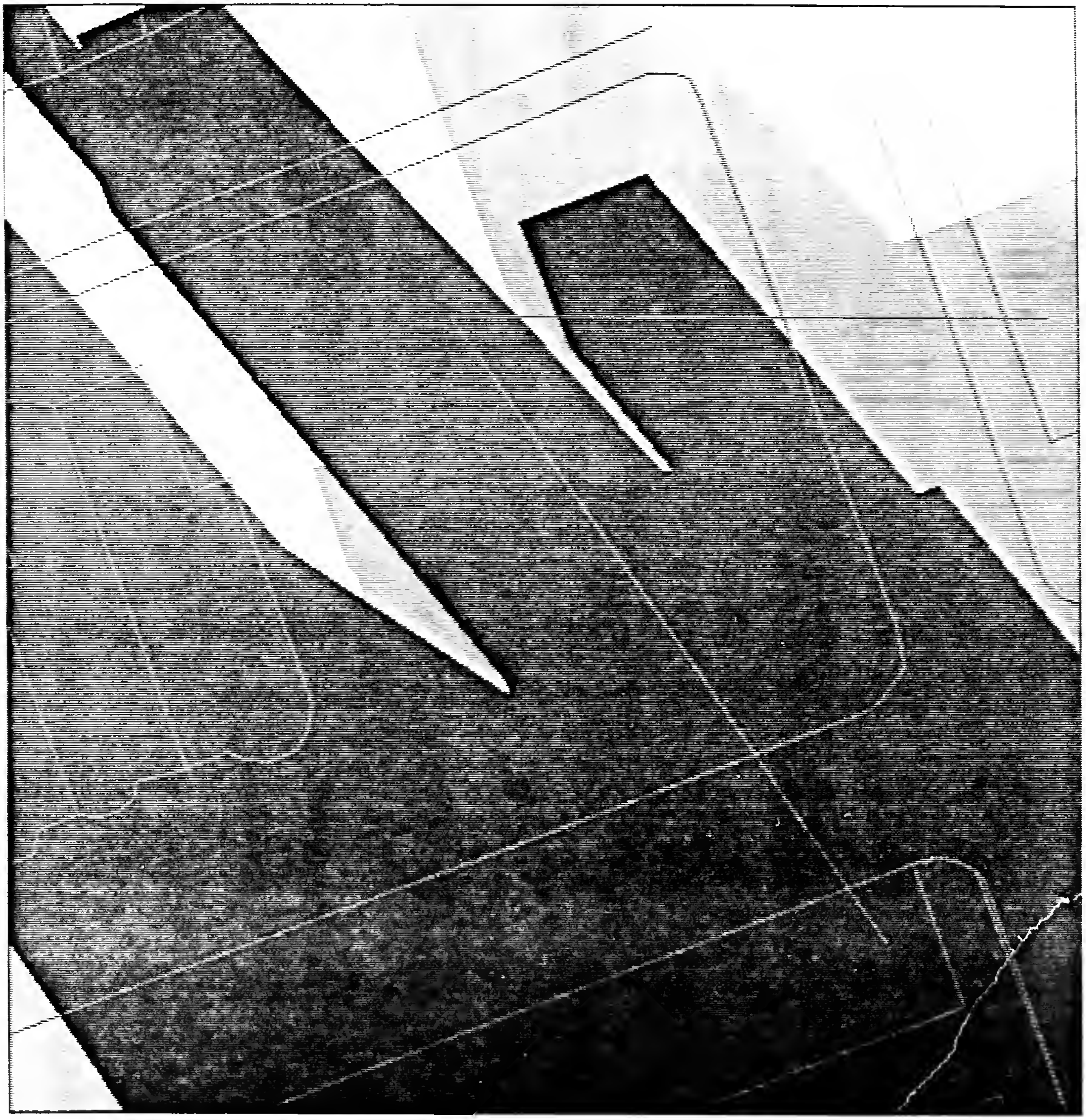
Existing shadow

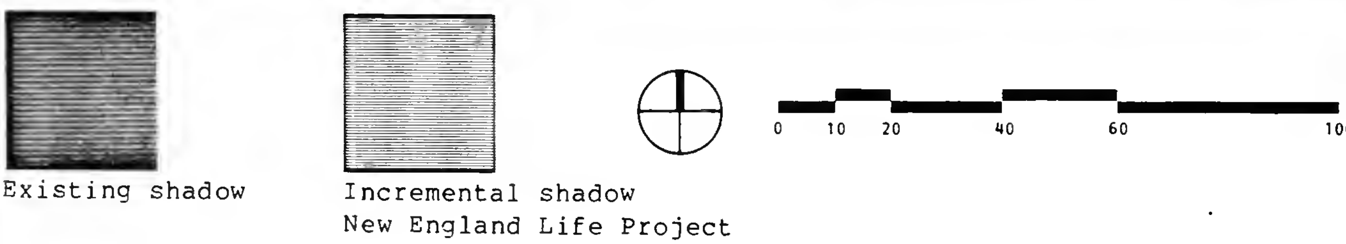
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

16 November 8:30am

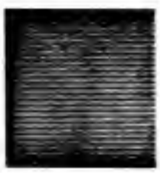




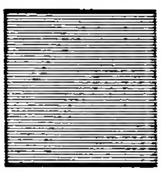
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

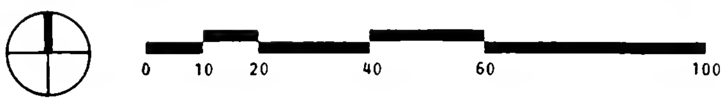
16 November 8:45am



Existing shadow



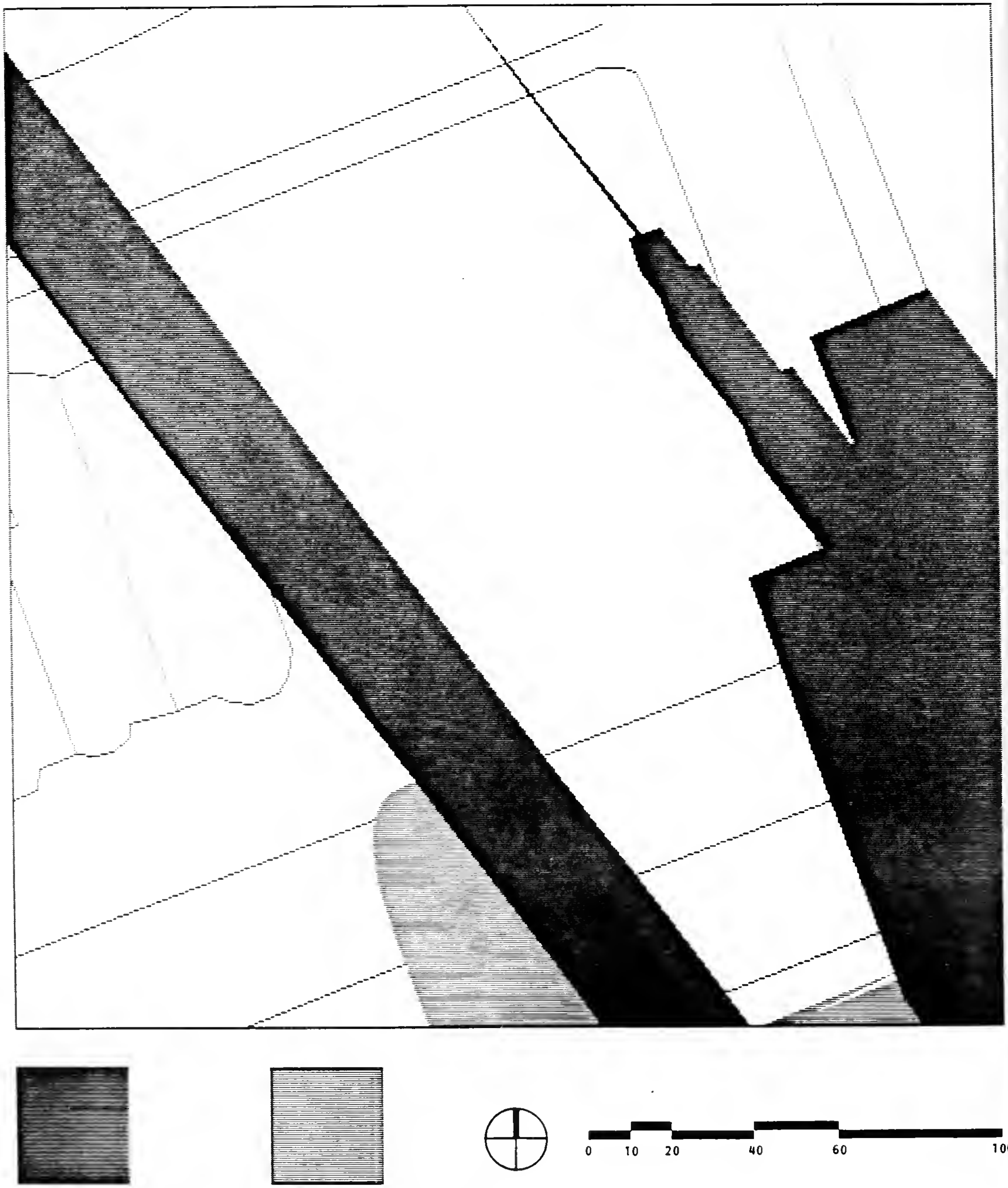
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

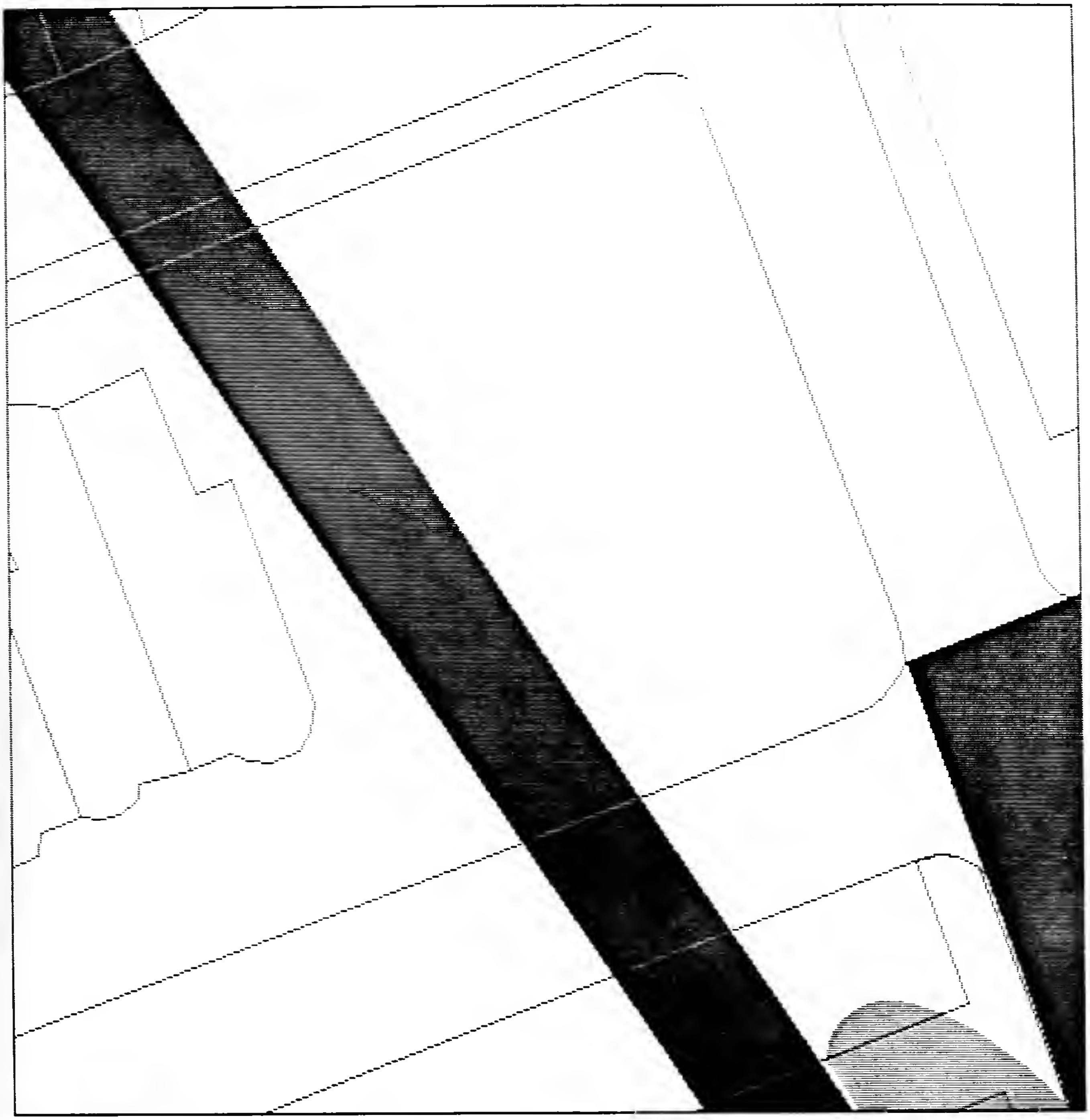
16 November 9:00am

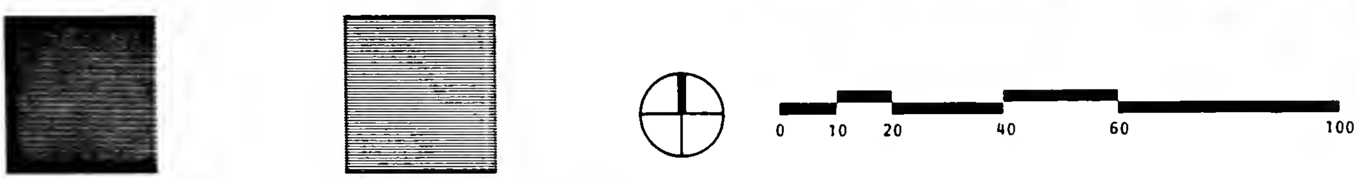


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

16 November 9:15am





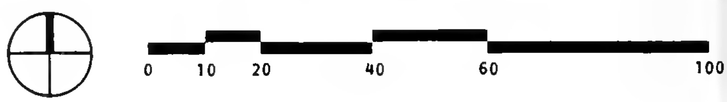
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

16 November 9:30am



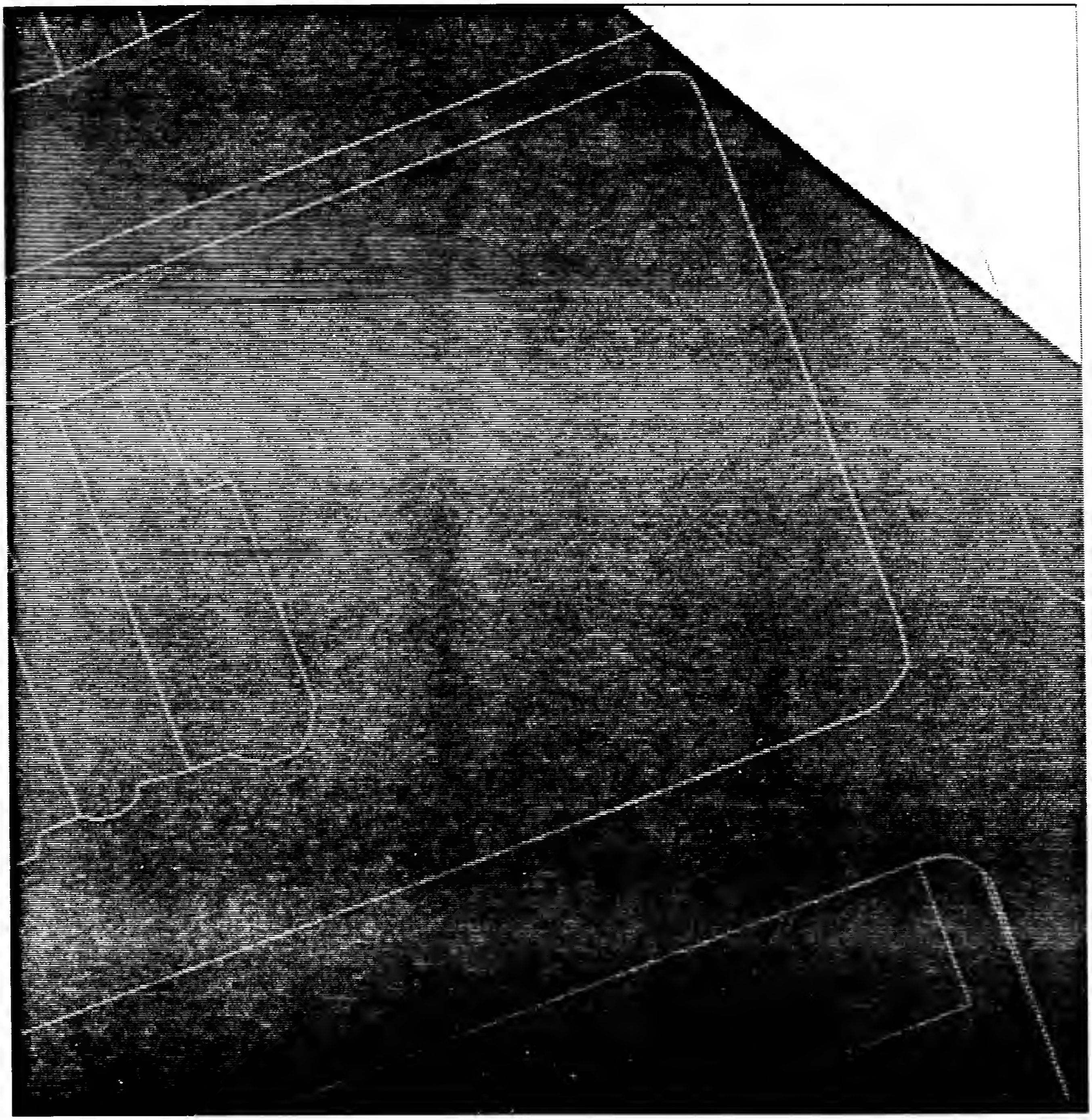
Existing shadow

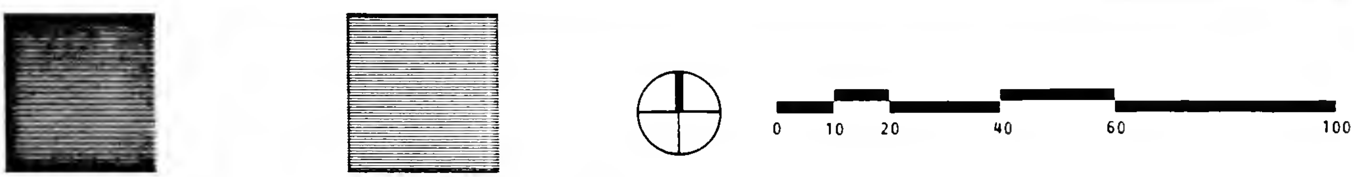
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

23 November 7:45am





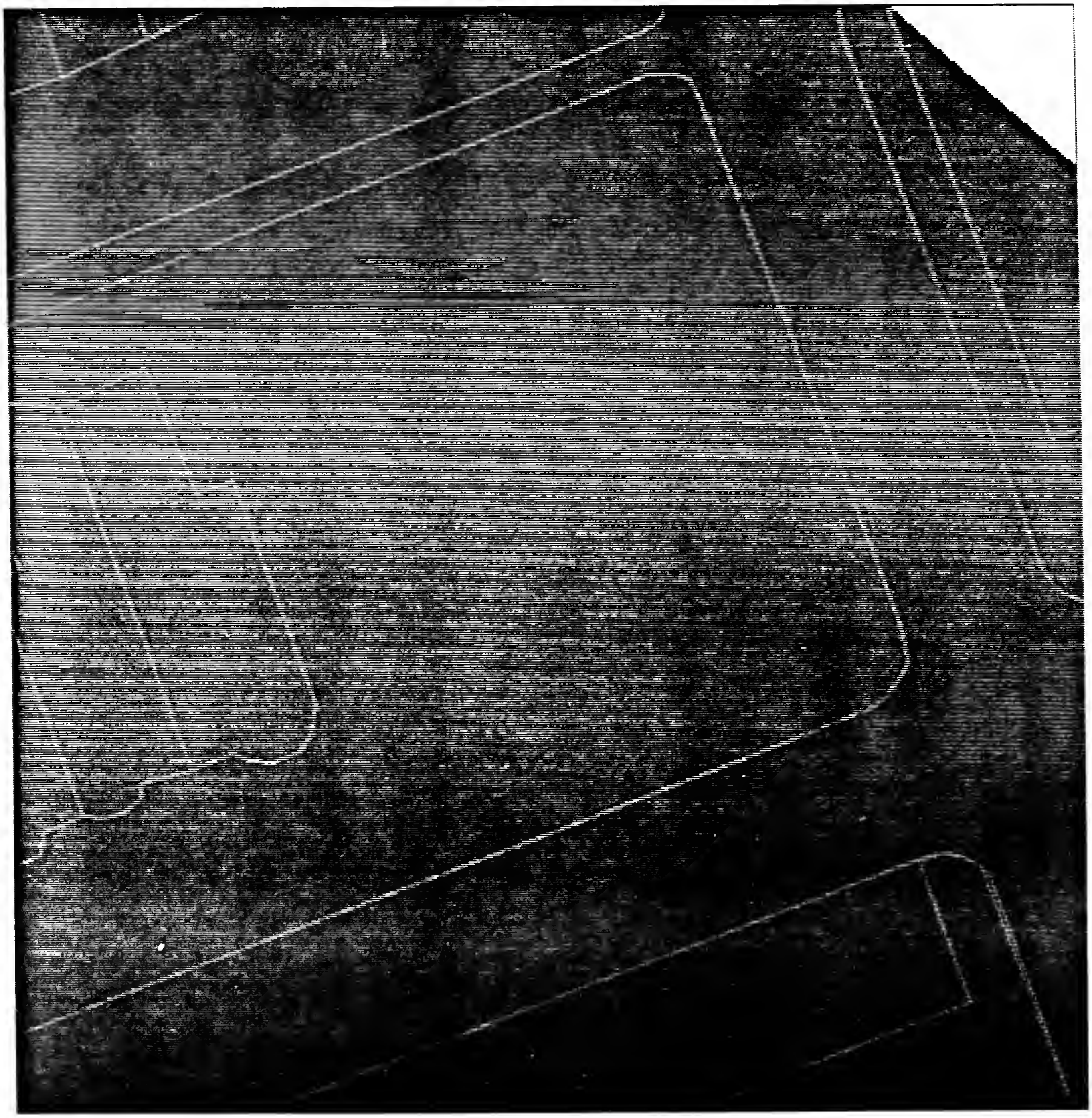
Existing shadow

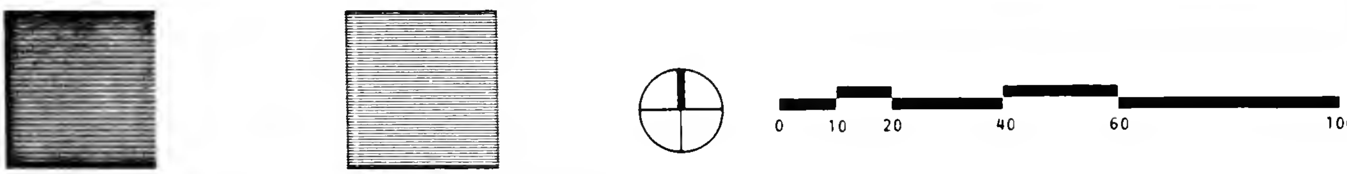
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

23 November 8:00am





Existing shadow

Incremental shadow
New England Life Project

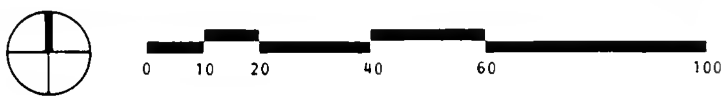
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

23 November 8:15am

Existing shadow

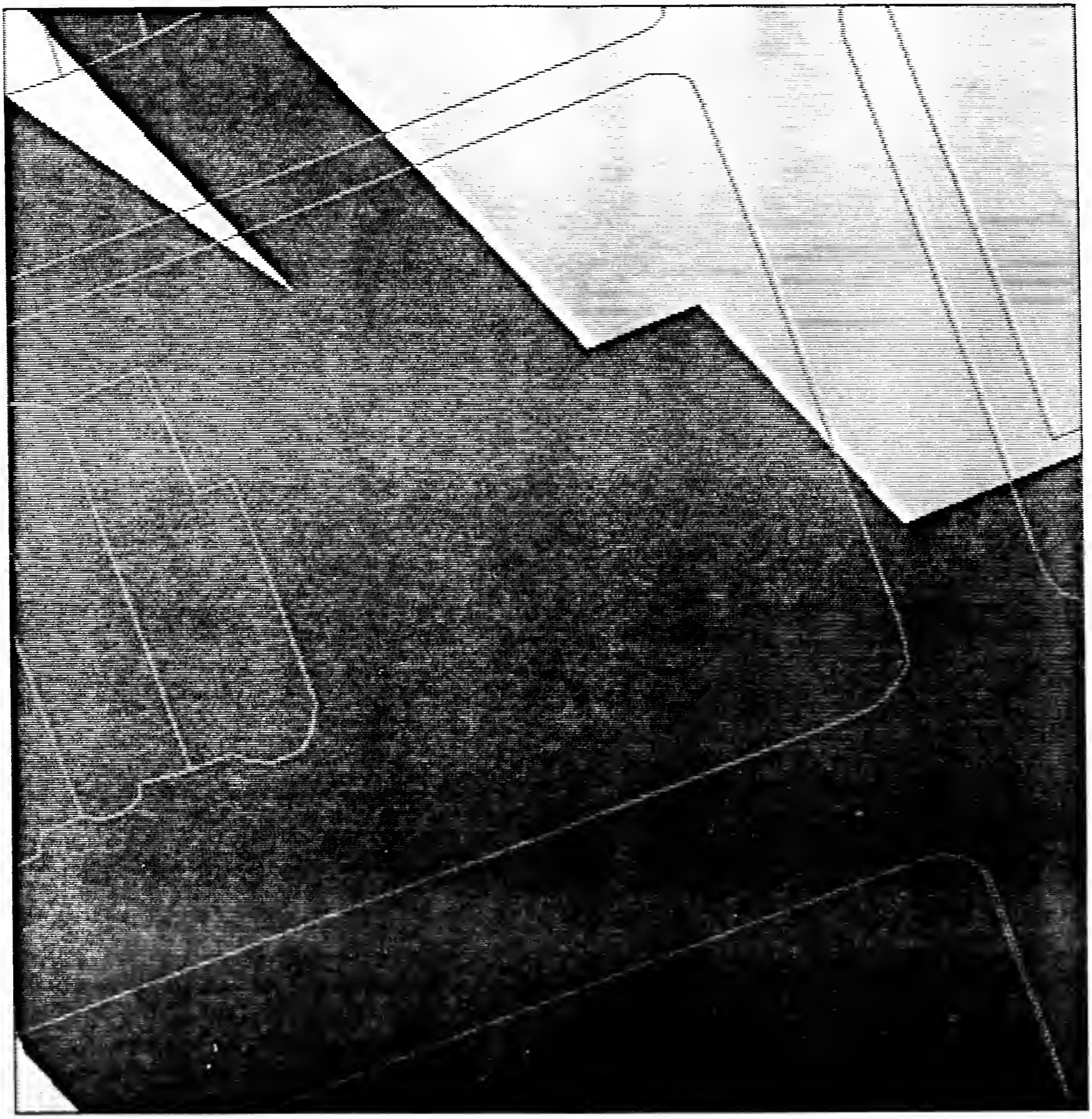
Incremental shadow
New England Life Project

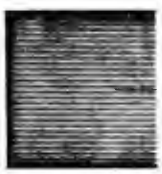


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

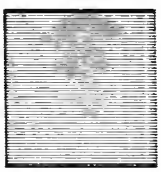
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

23 November 8:30am

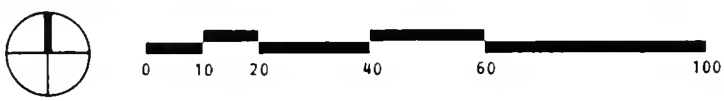




Existing shadow



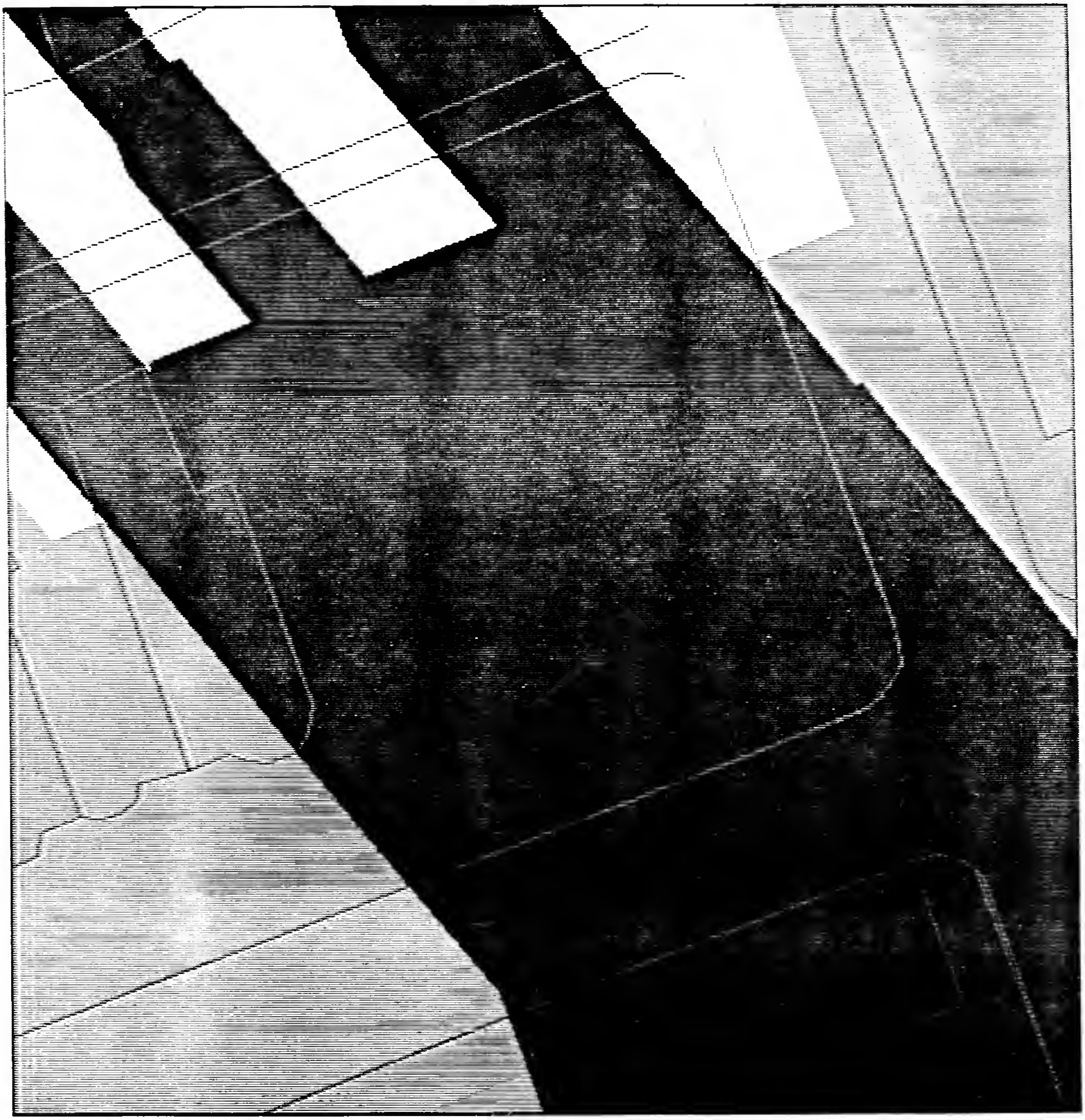
Incremental shadow
New England Life Project

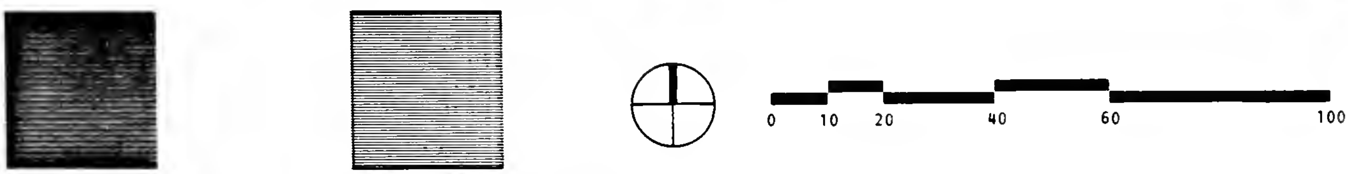


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

23 November 8:45am





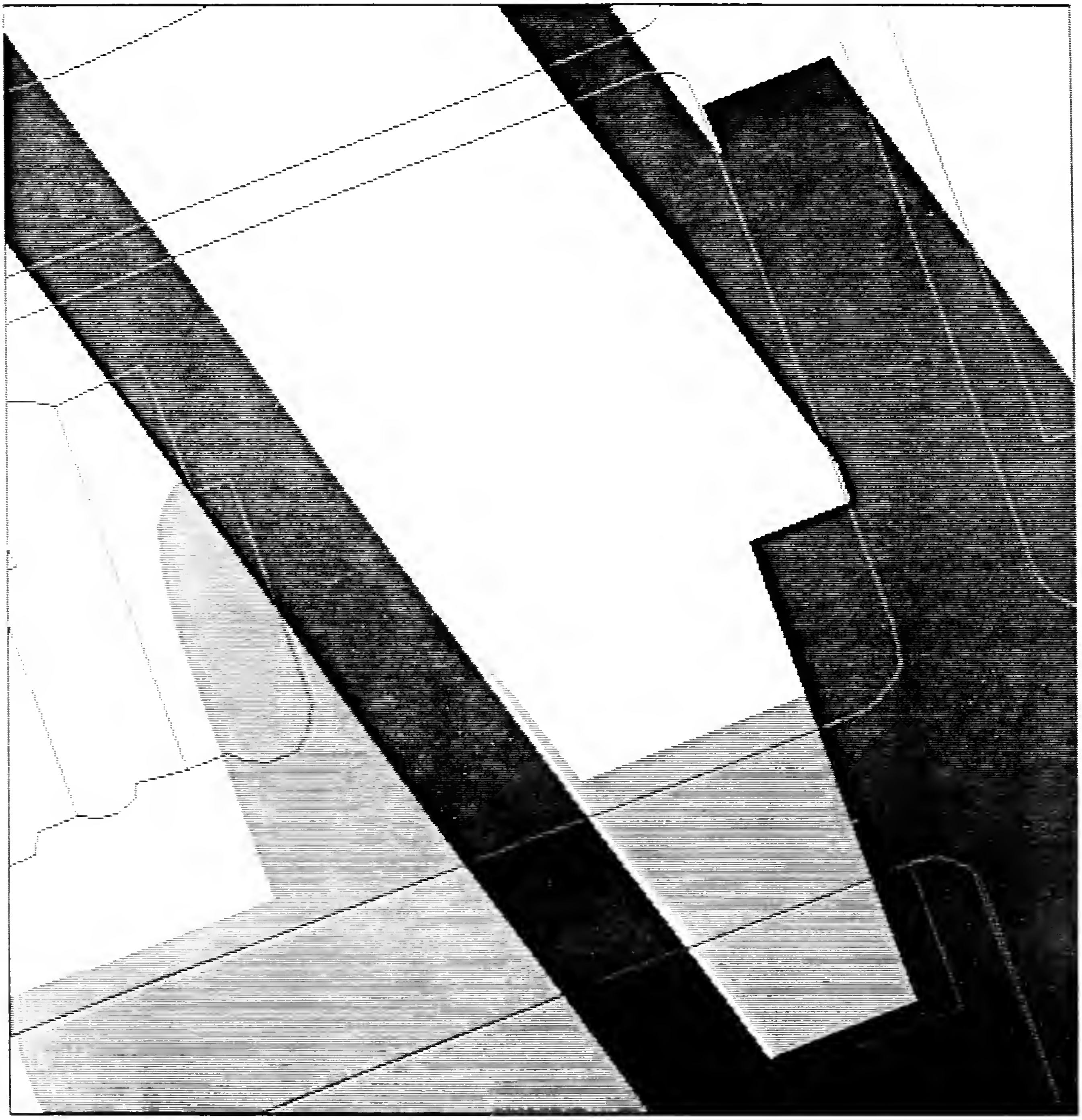
Existing shadow

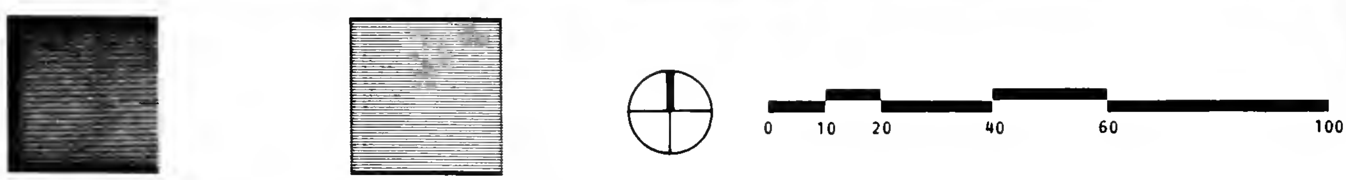
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

23 November 9:00am





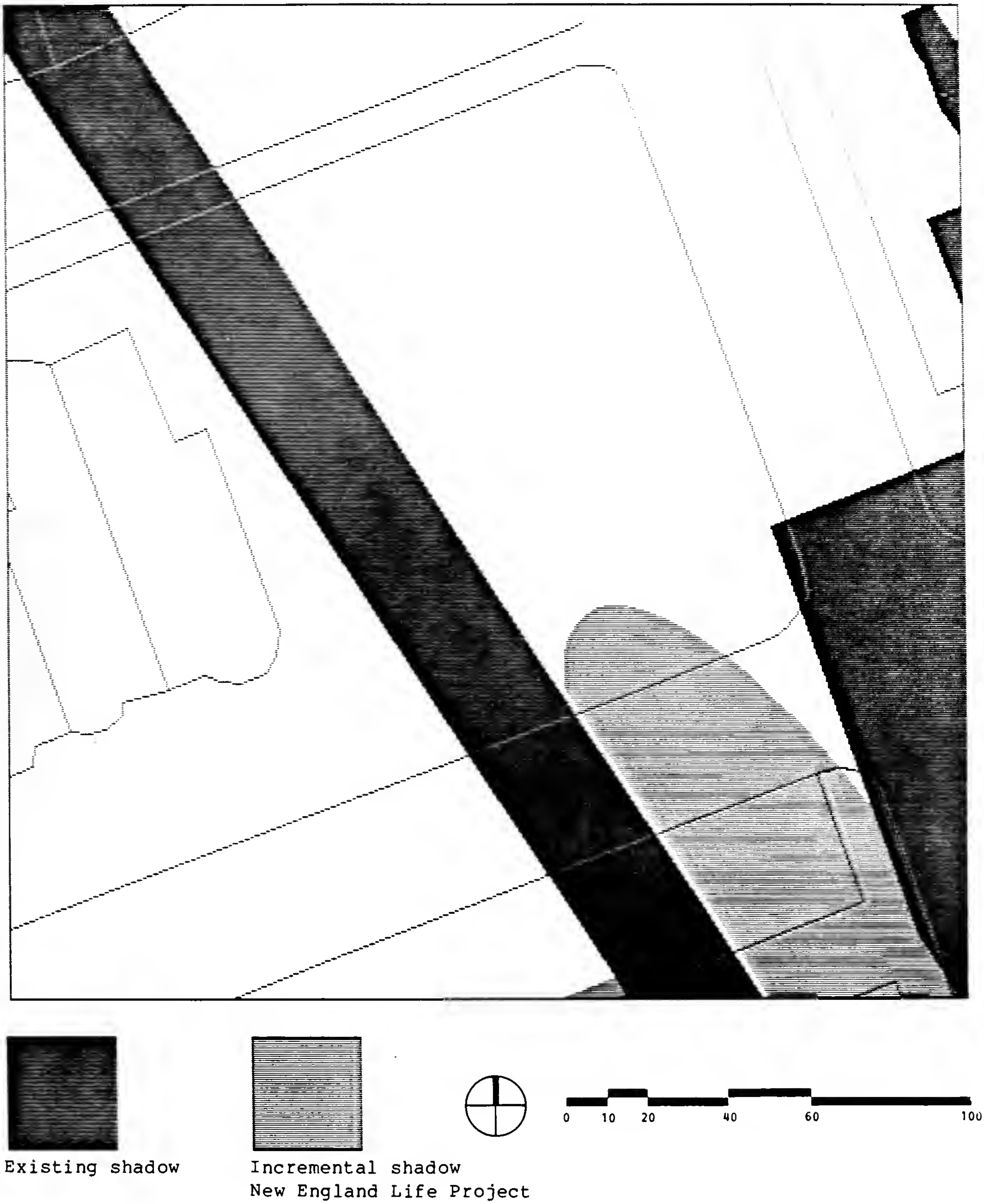
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

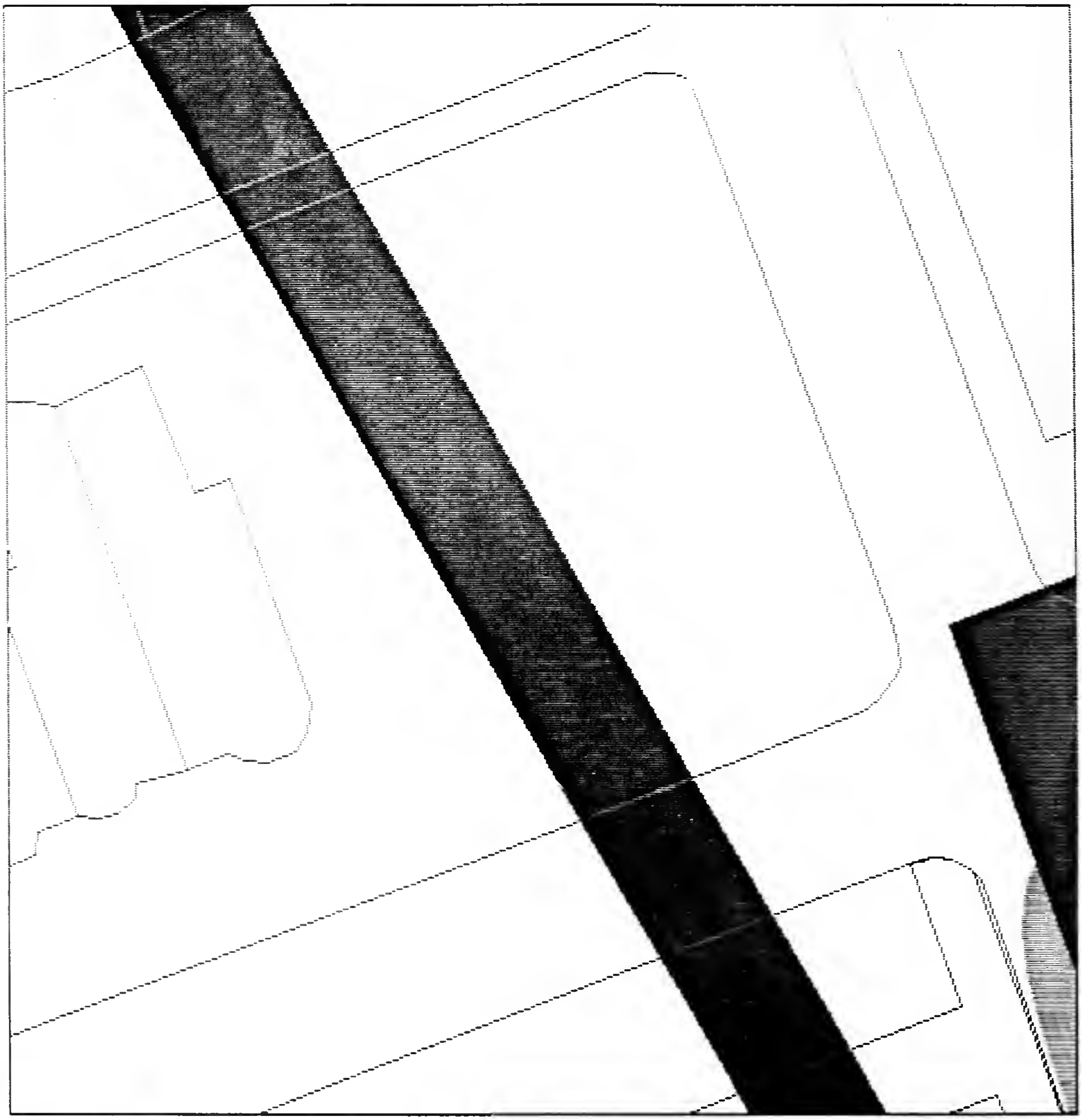
23 November 9:15am



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

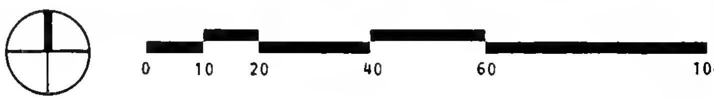
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

23 November 9:30am



Existing shadow

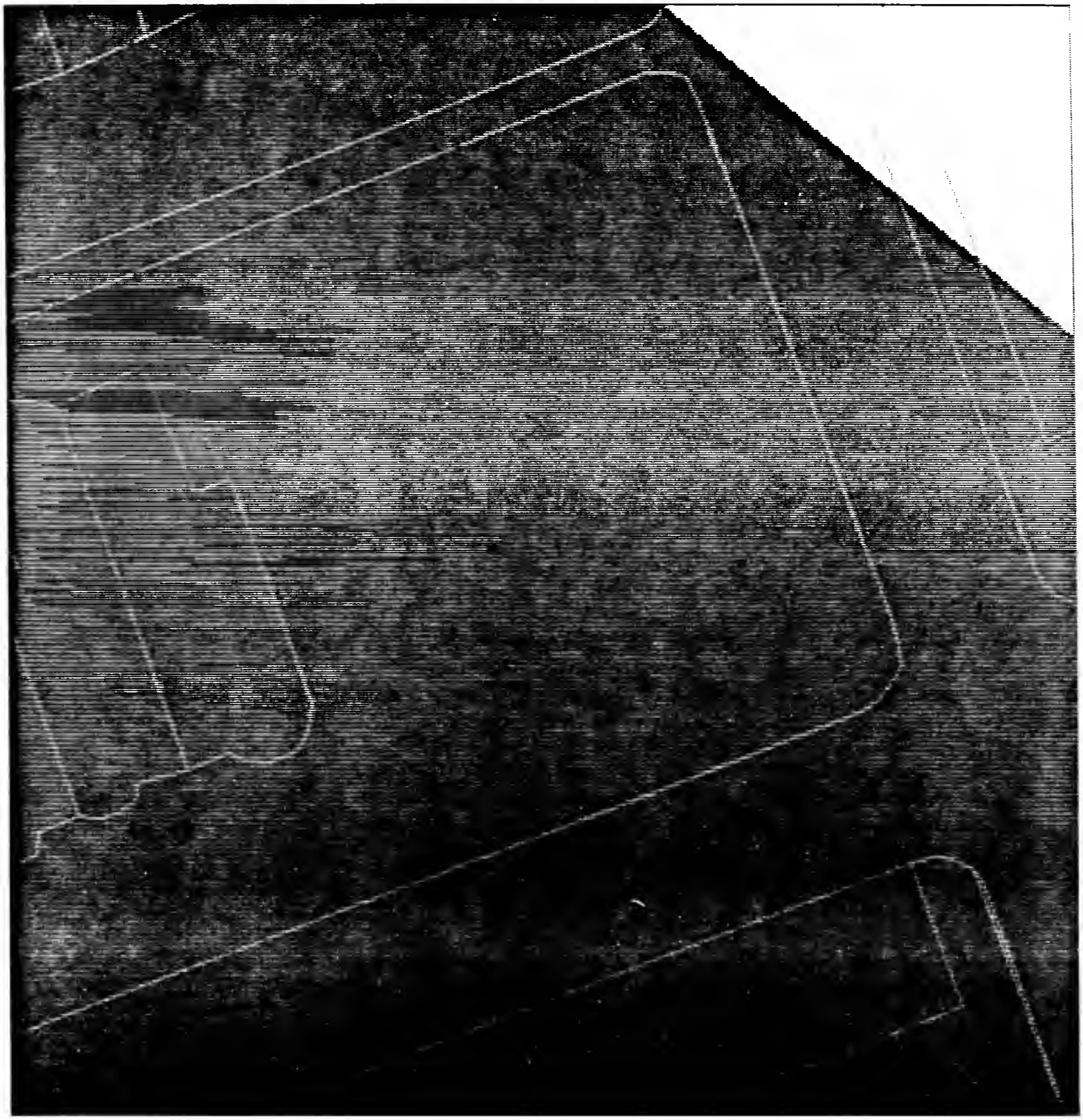
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

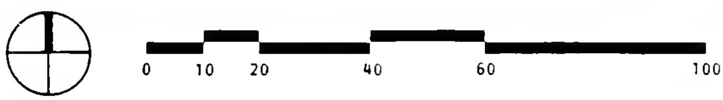
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

30 November 7:45am



Existing shadow

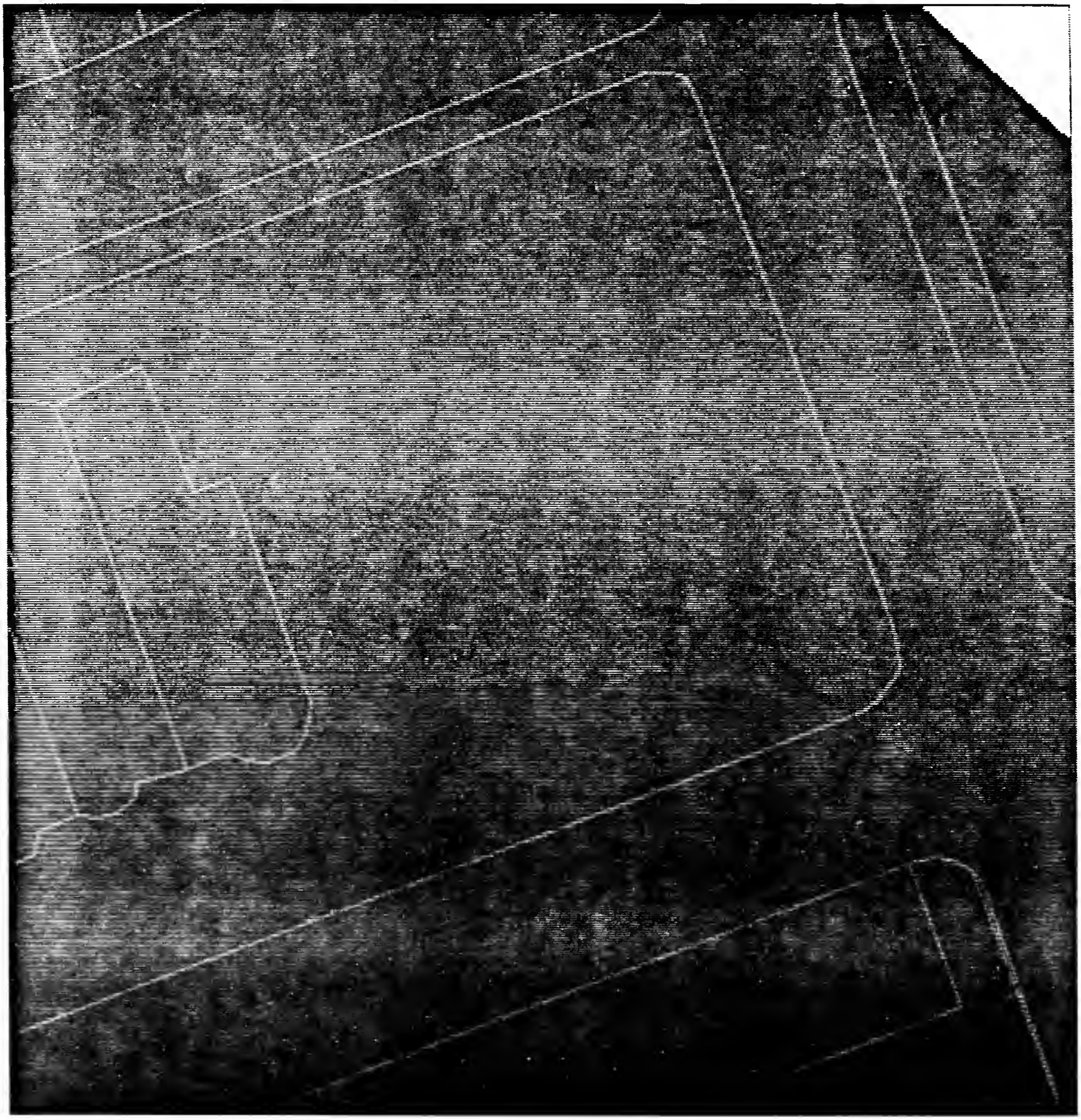
Incremental shadow
New England Life Project

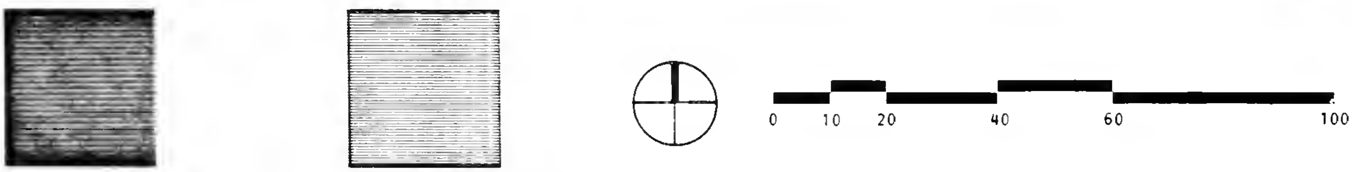


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

30 November 8:00am





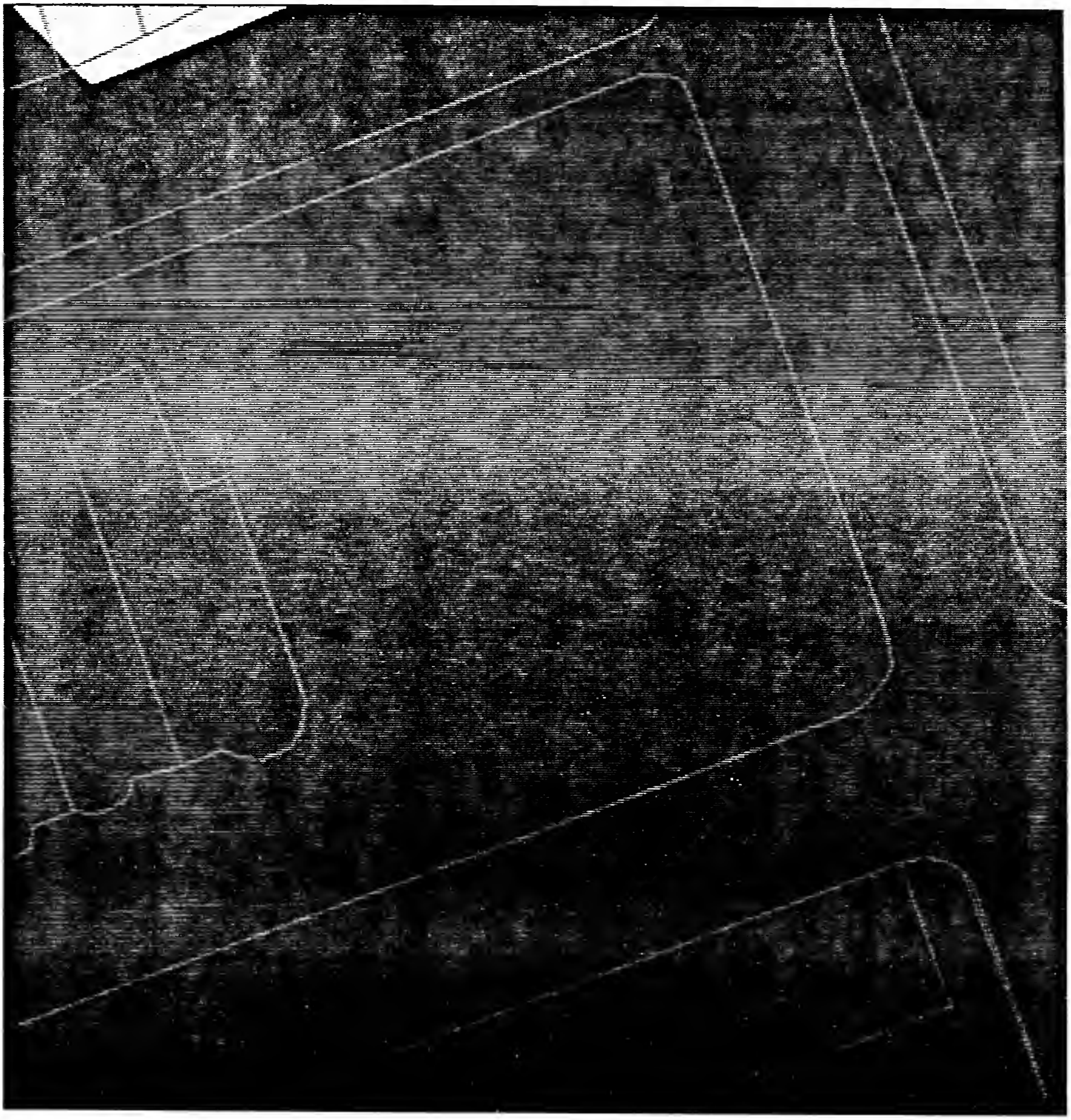
Existing shadow

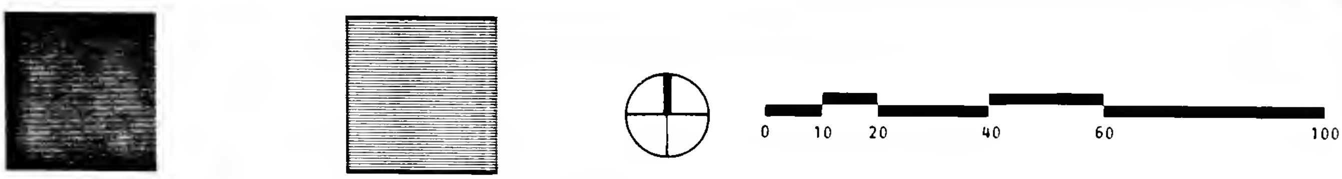
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

30 November 8:15am





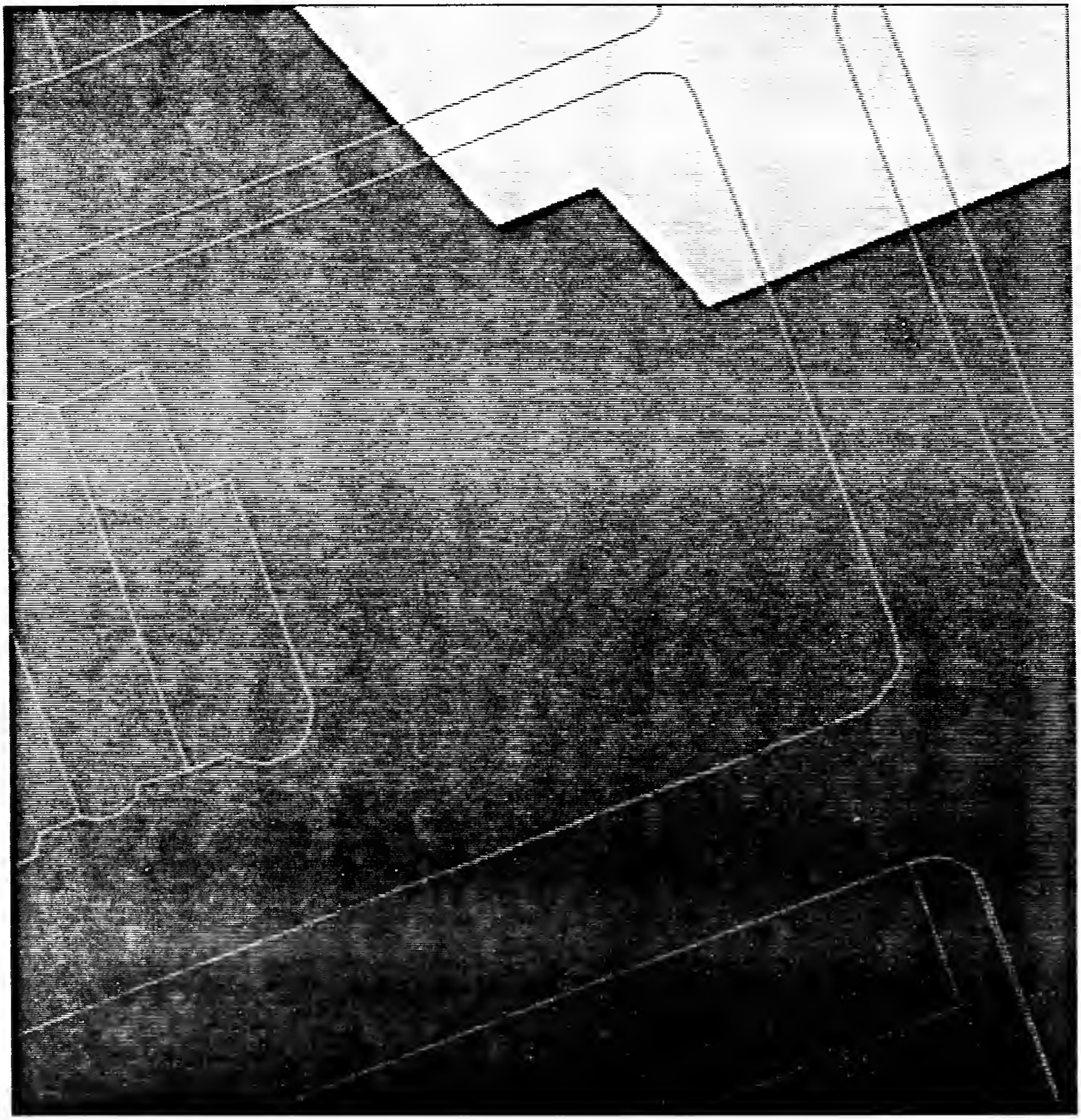
Existing shadow

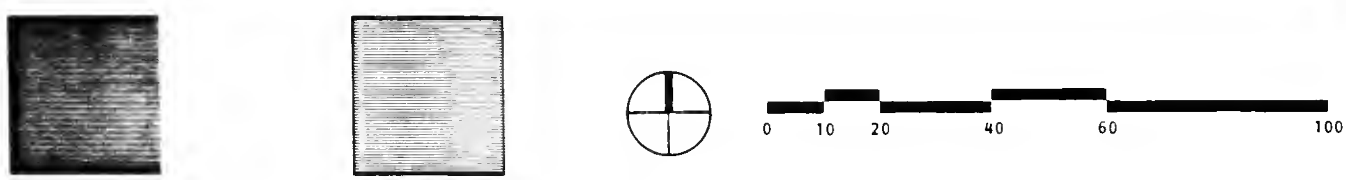
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

30 November 8:30am





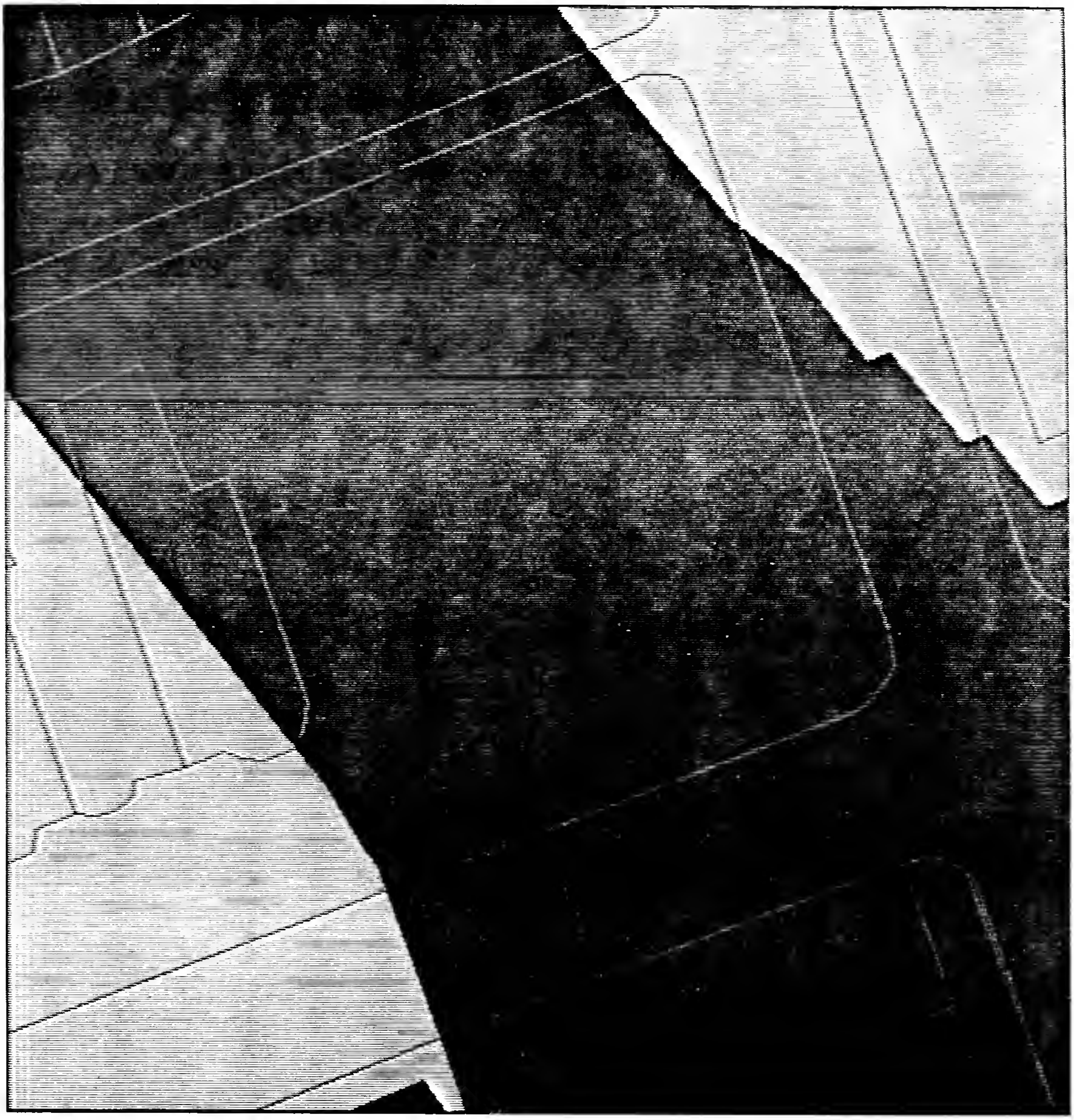
Existing shadow

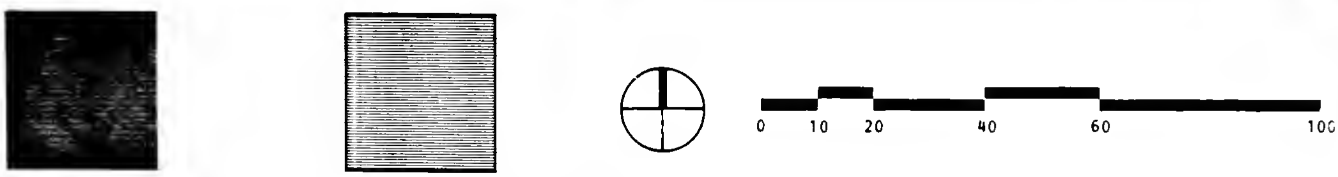
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

30 November 8:45am





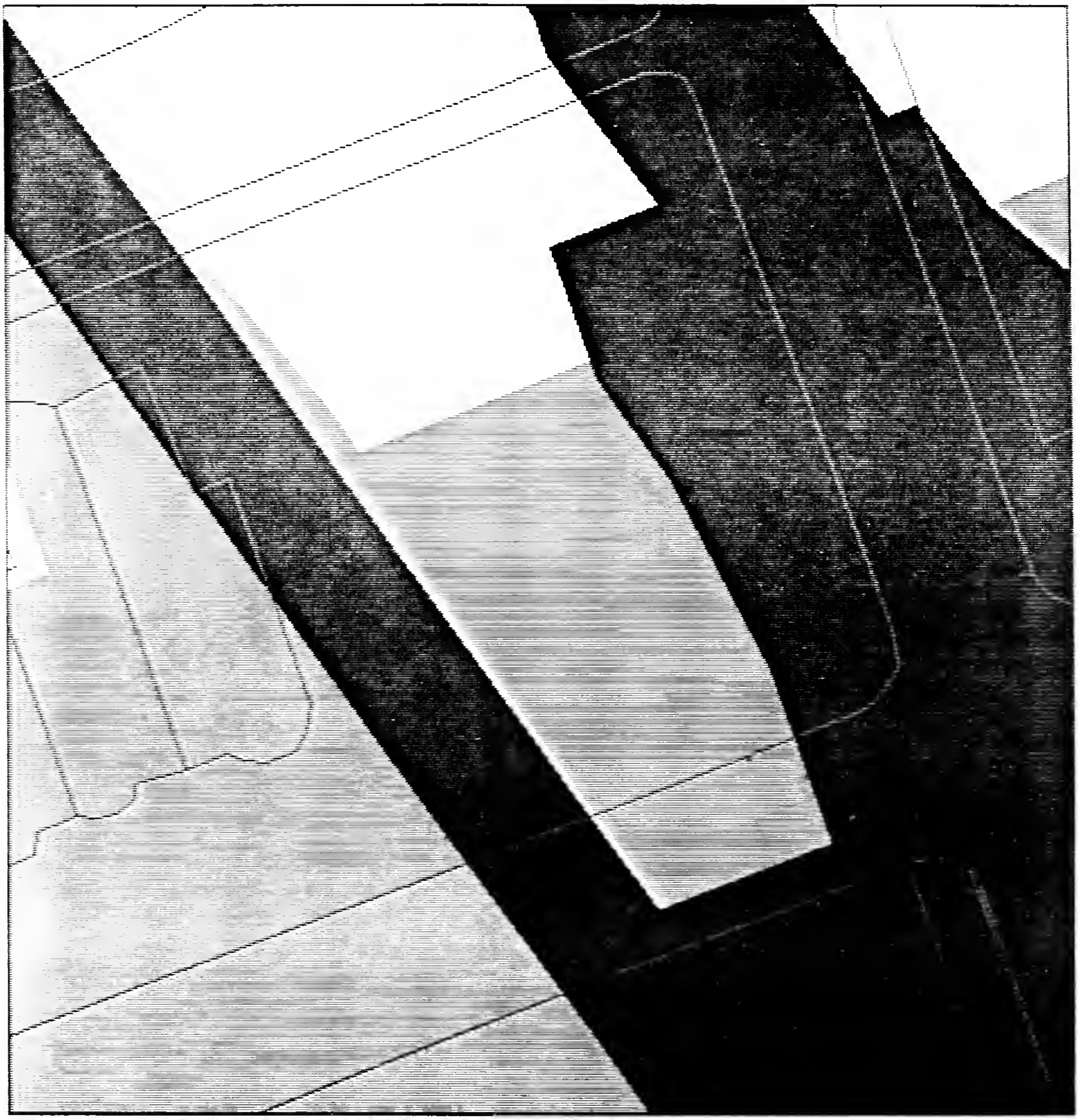
Existing shadow

Incremental shadow
New England Life Project

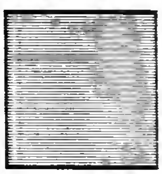
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

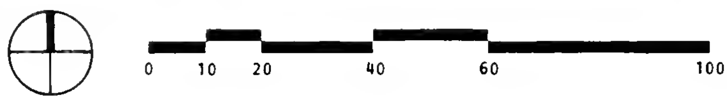
30 November 9:00am



Existing shadow



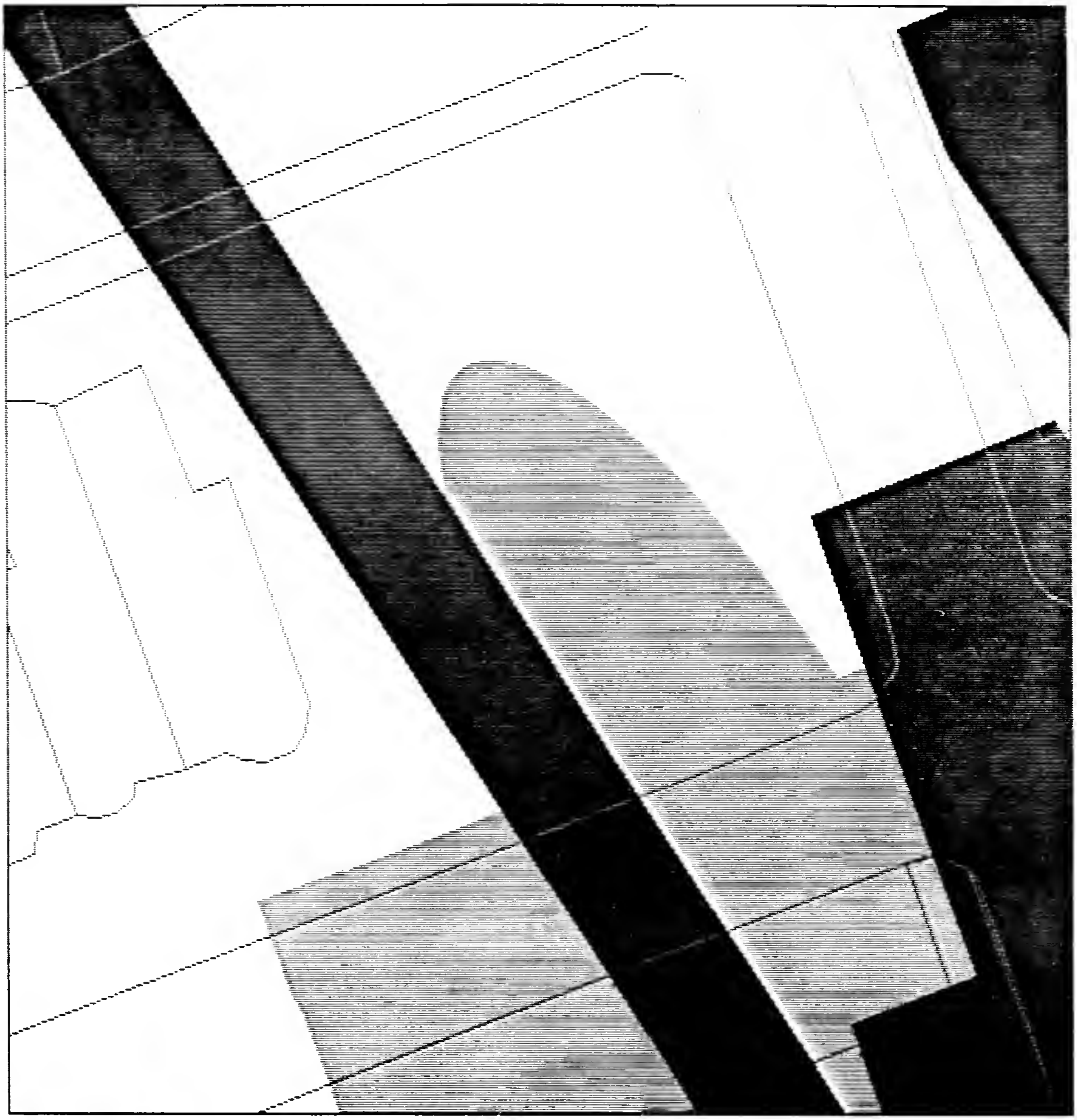
Incremental shadow
New England Life Project

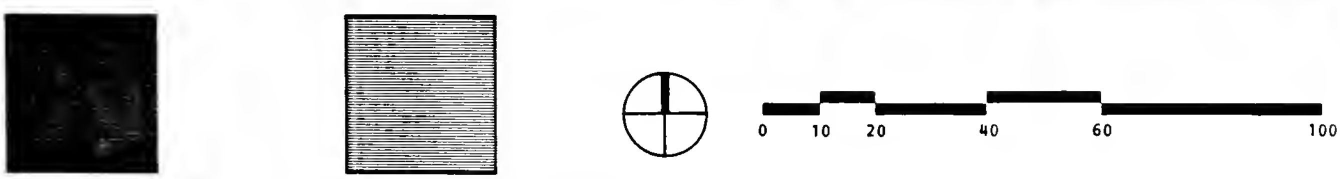


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

30 November 9:15am





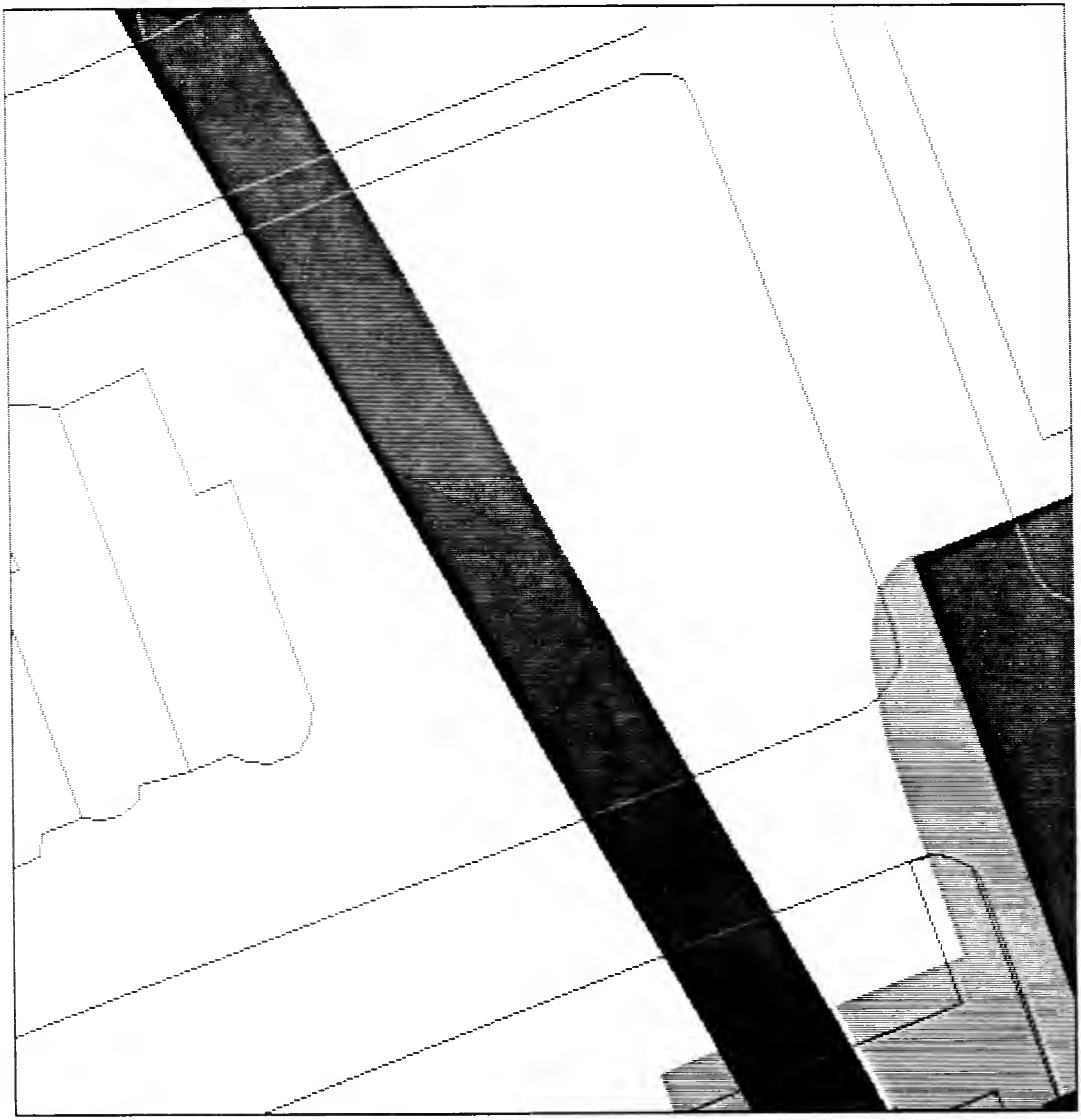
Existing shadow

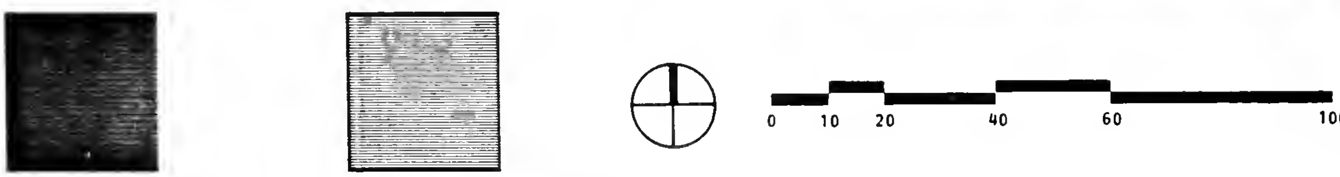
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

30 November 9:30am





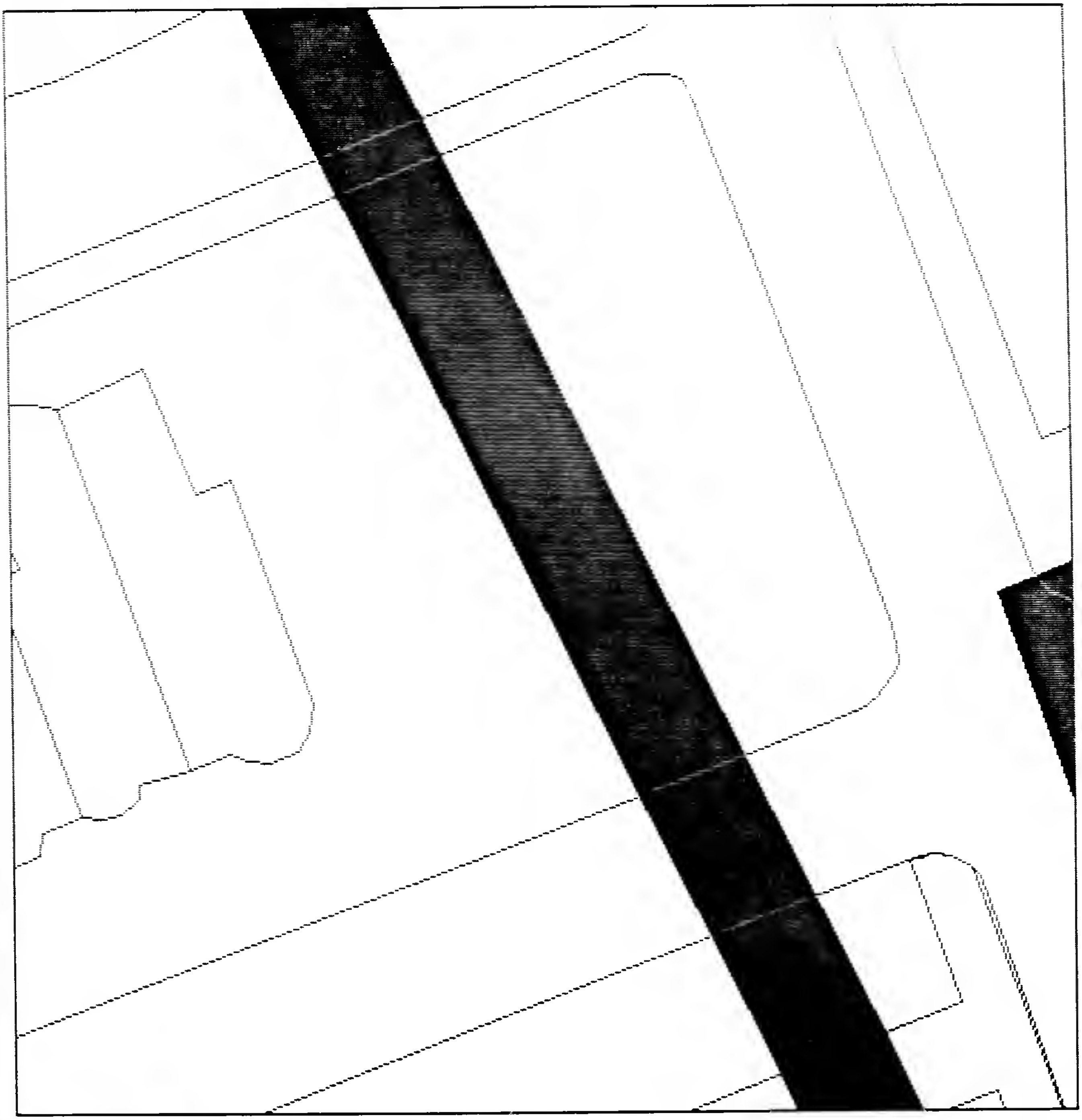
Existing shadow

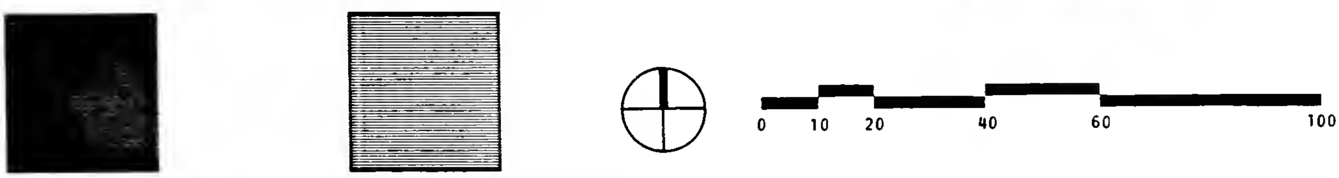
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

30 November 9:45am





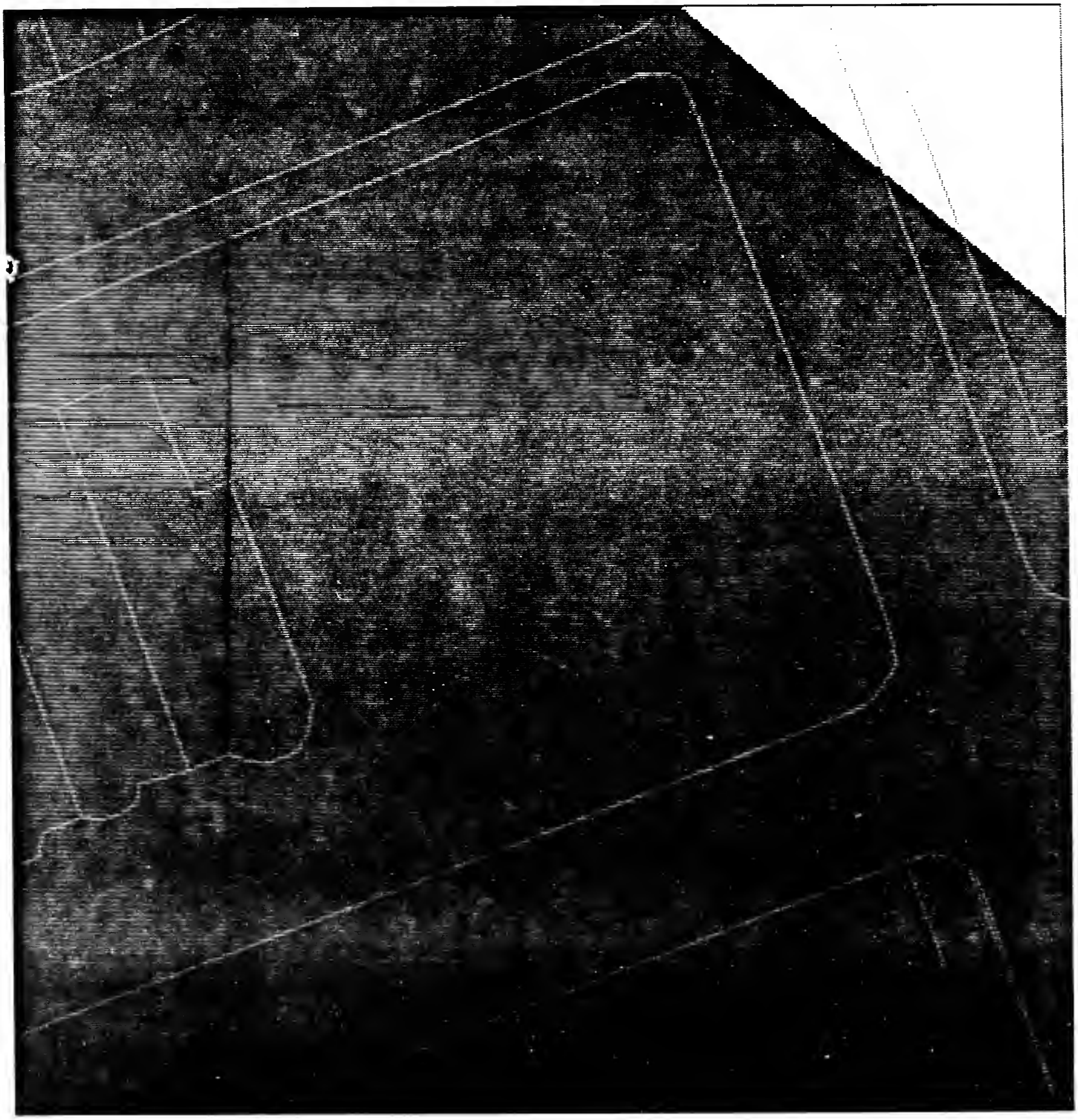
Existing shadow

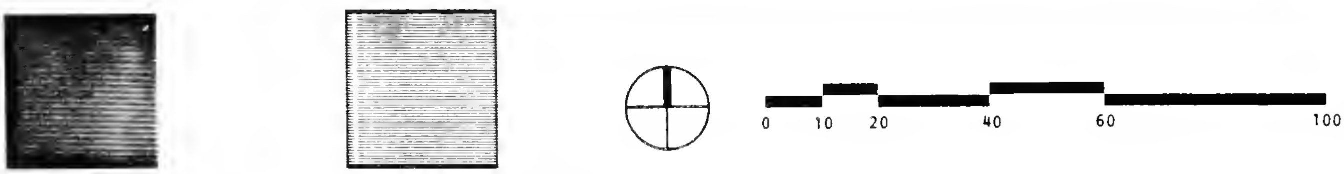
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

7 December 7:45am





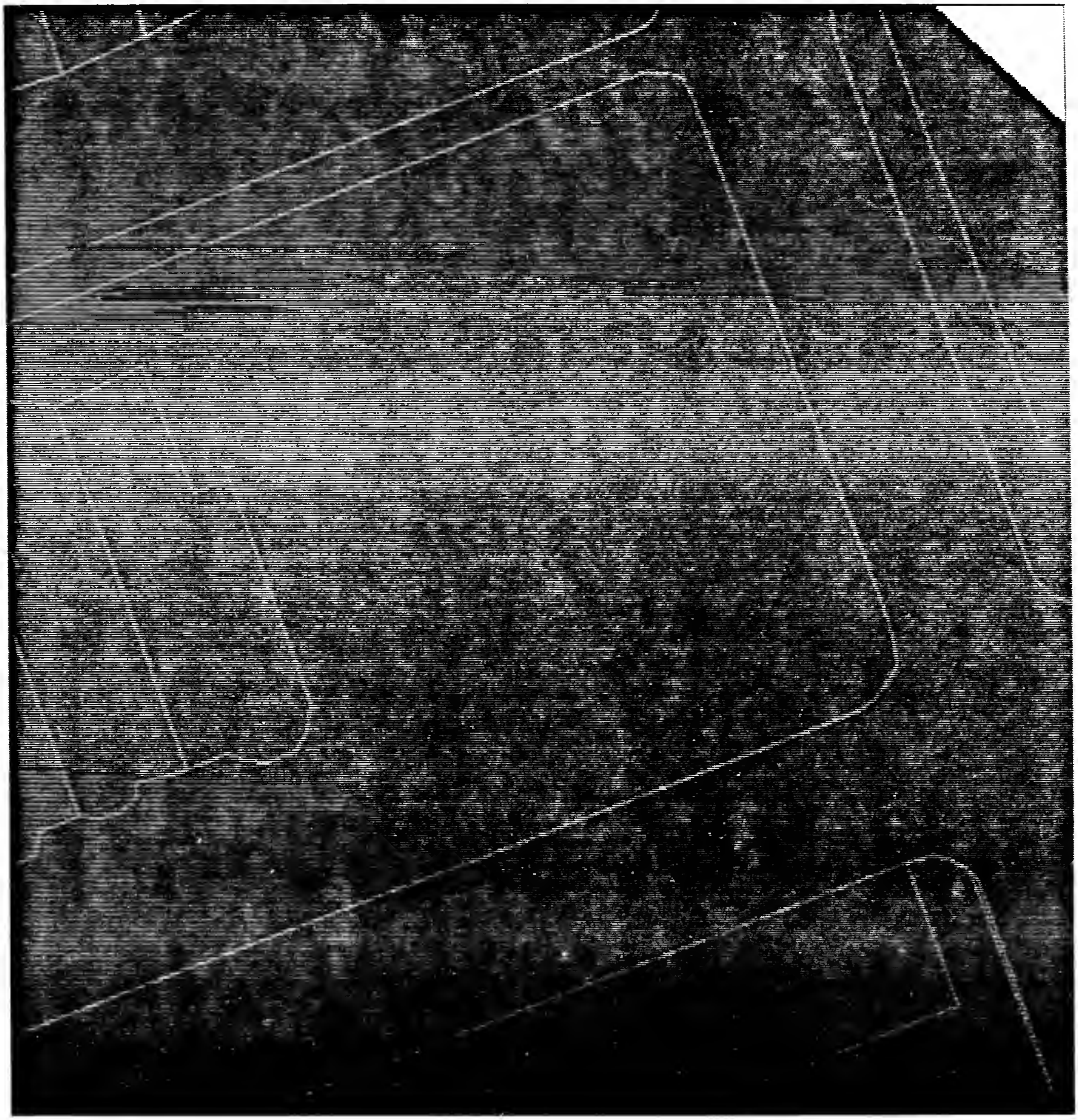
Existing shadow

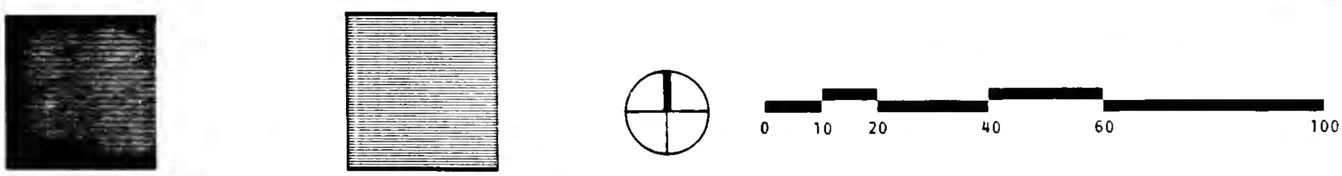
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

7 December 8:00am





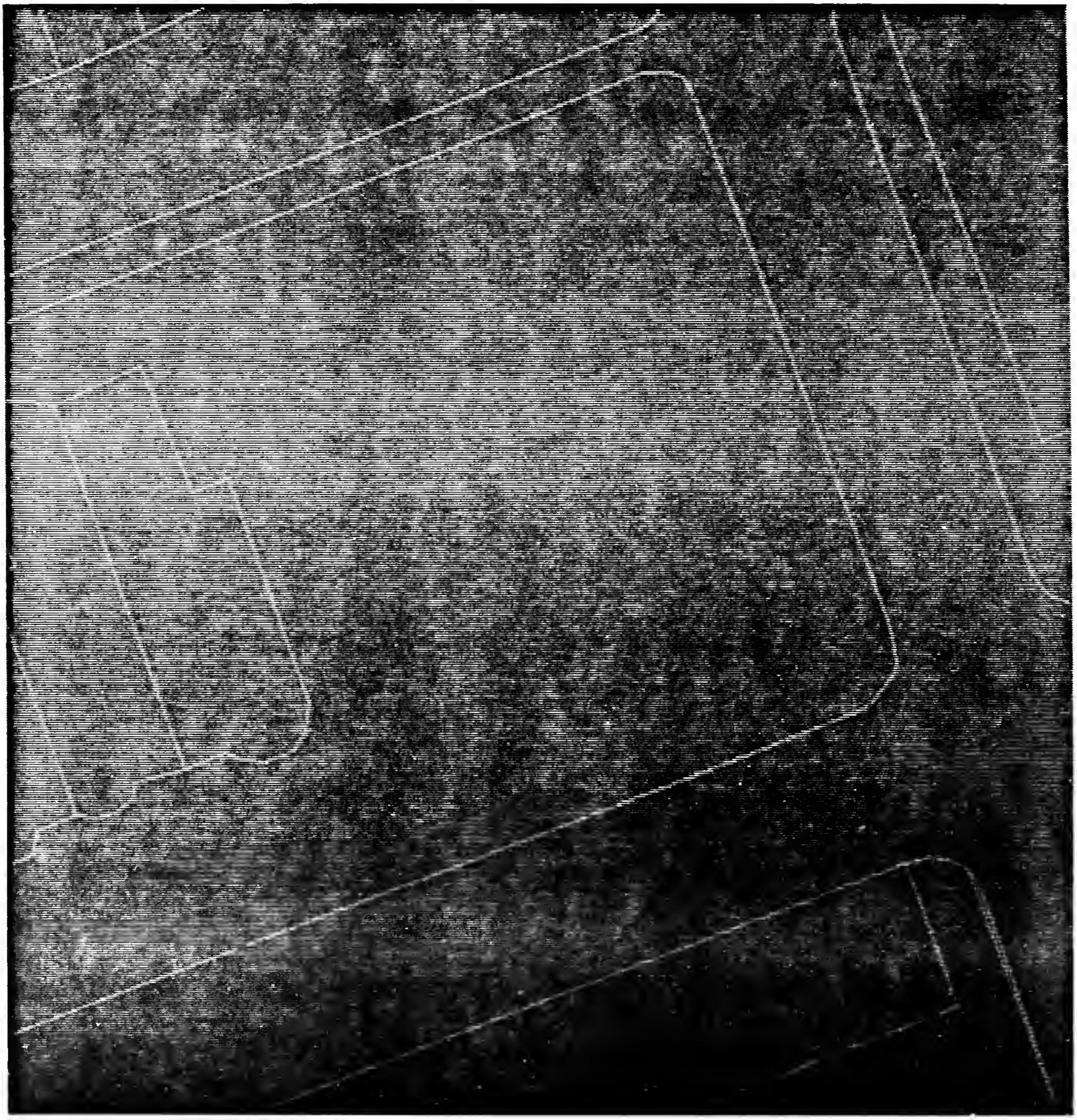
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

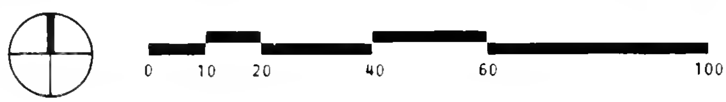
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

7 December 8:15am



Existing shadow

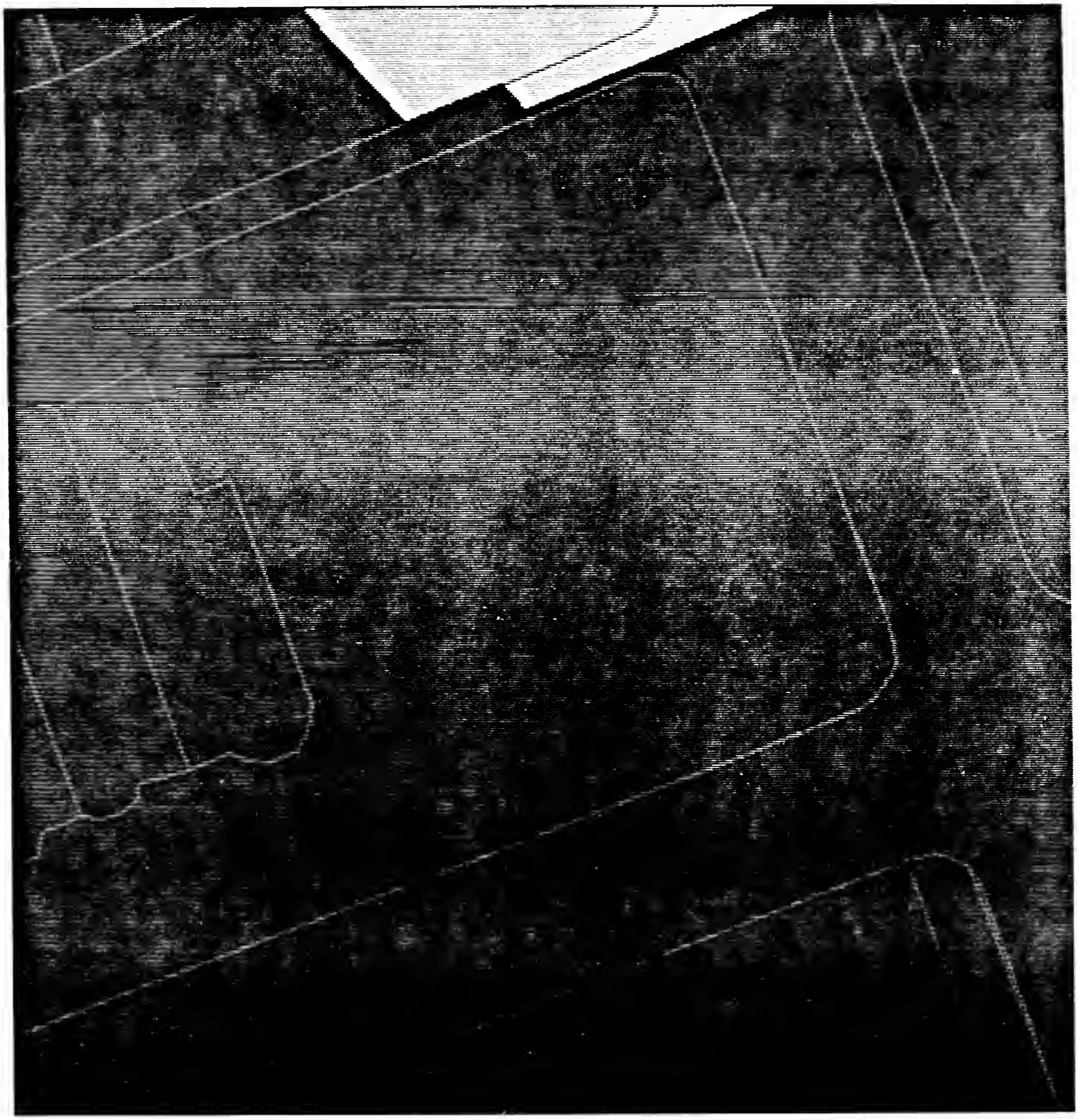
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

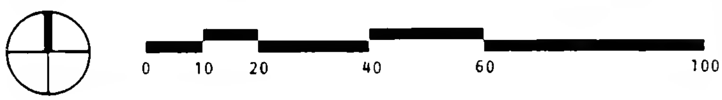
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

7 December 8:30am



Existing shadow

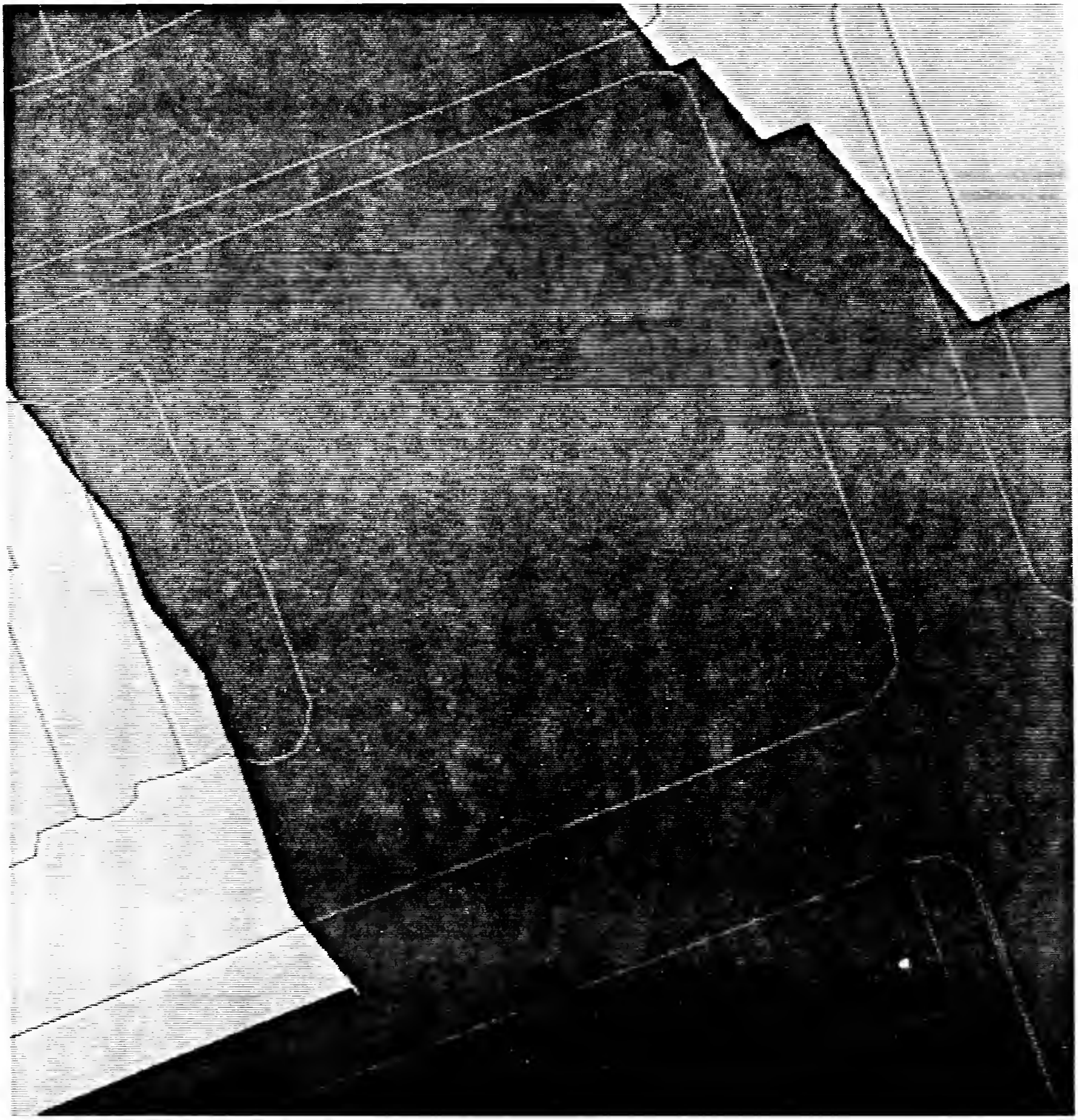
Incremental shadow
New England Life Project

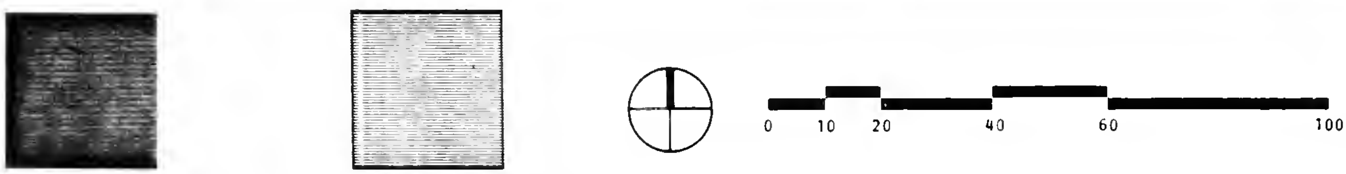


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

7 December 8:45am





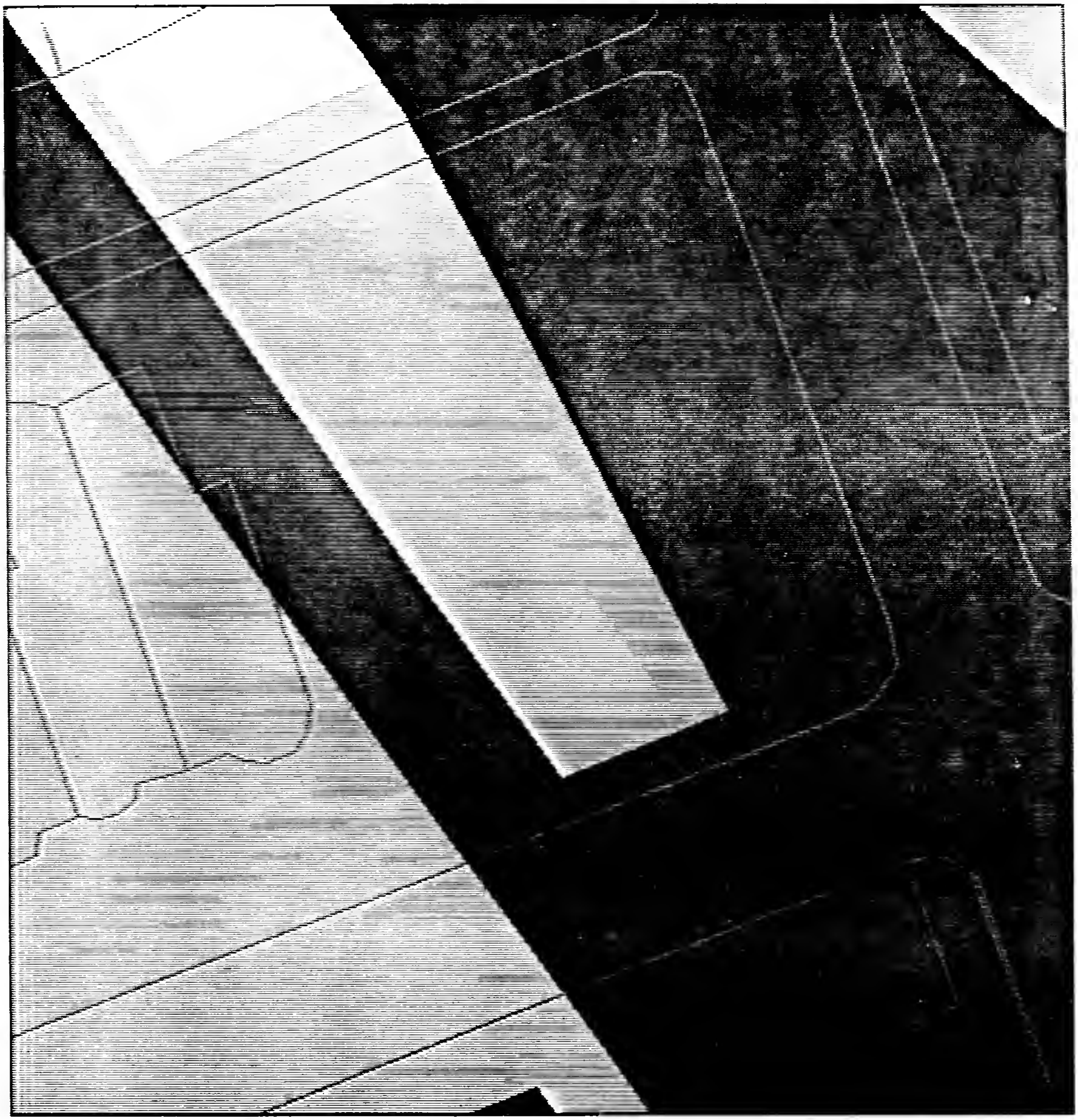
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

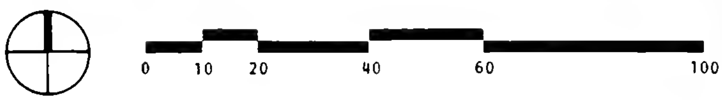
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

7 December 9:00am



Existing shadow

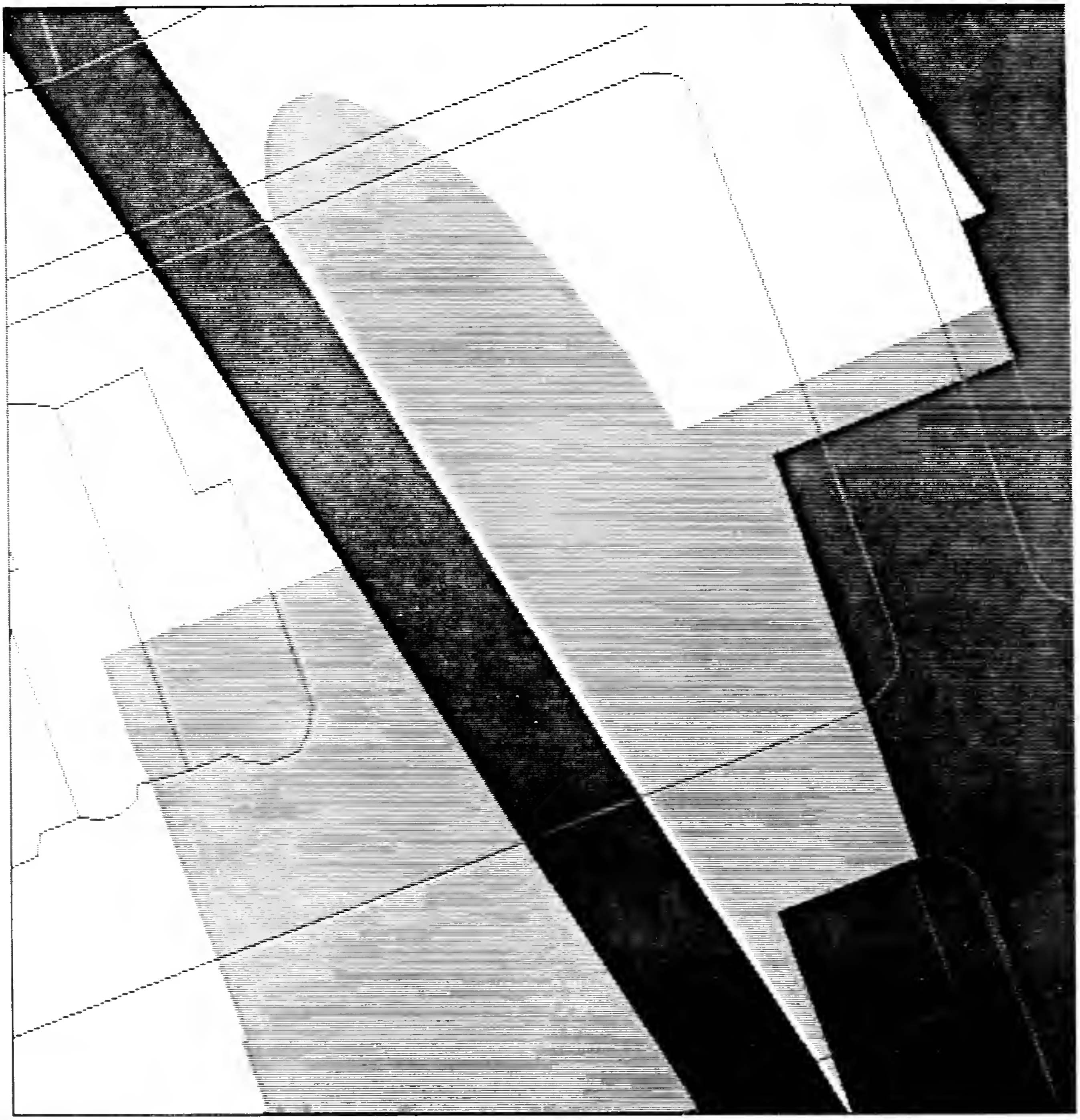
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

7 December 9:15am



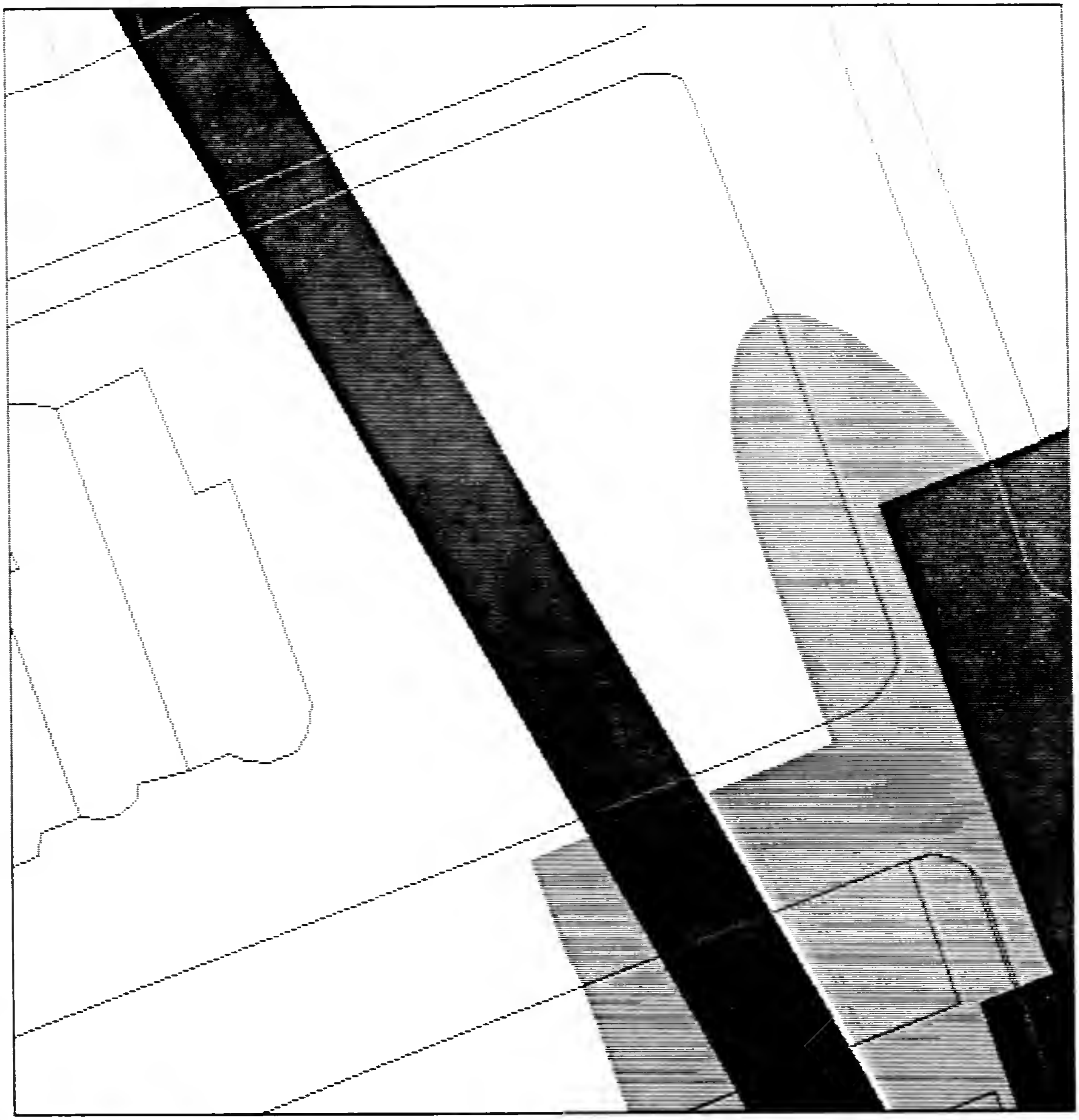
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

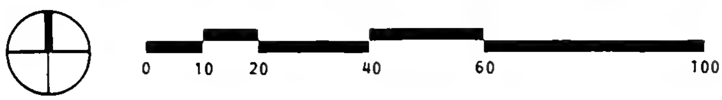
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

7 December 9:30am



Existing shadow

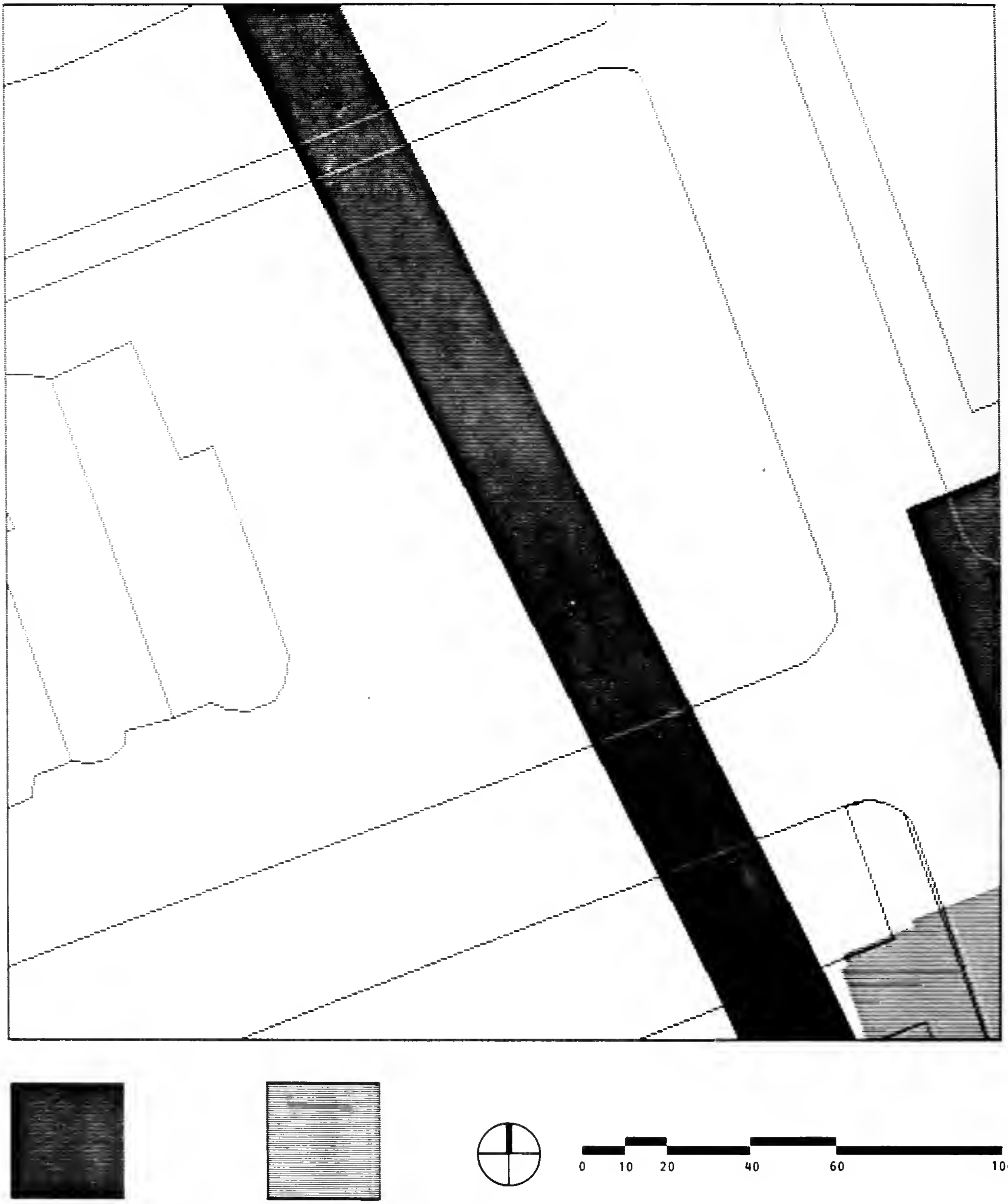
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

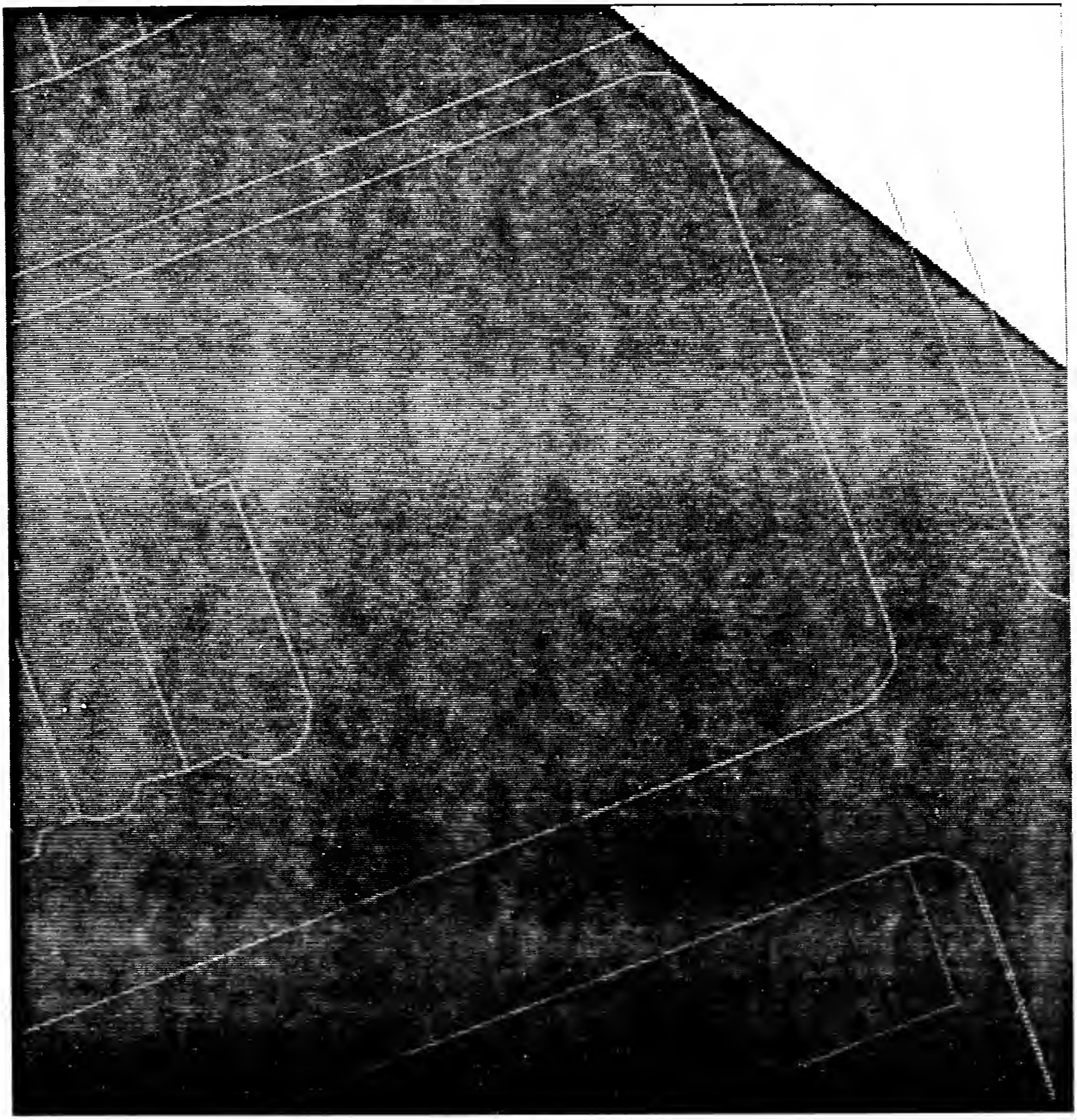
7 December 9:45am

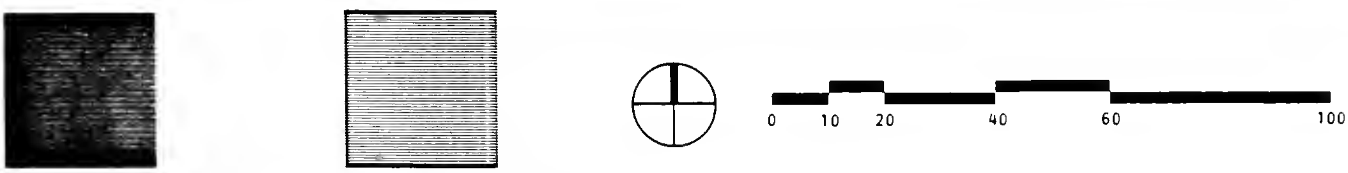


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

14 December 7:45am





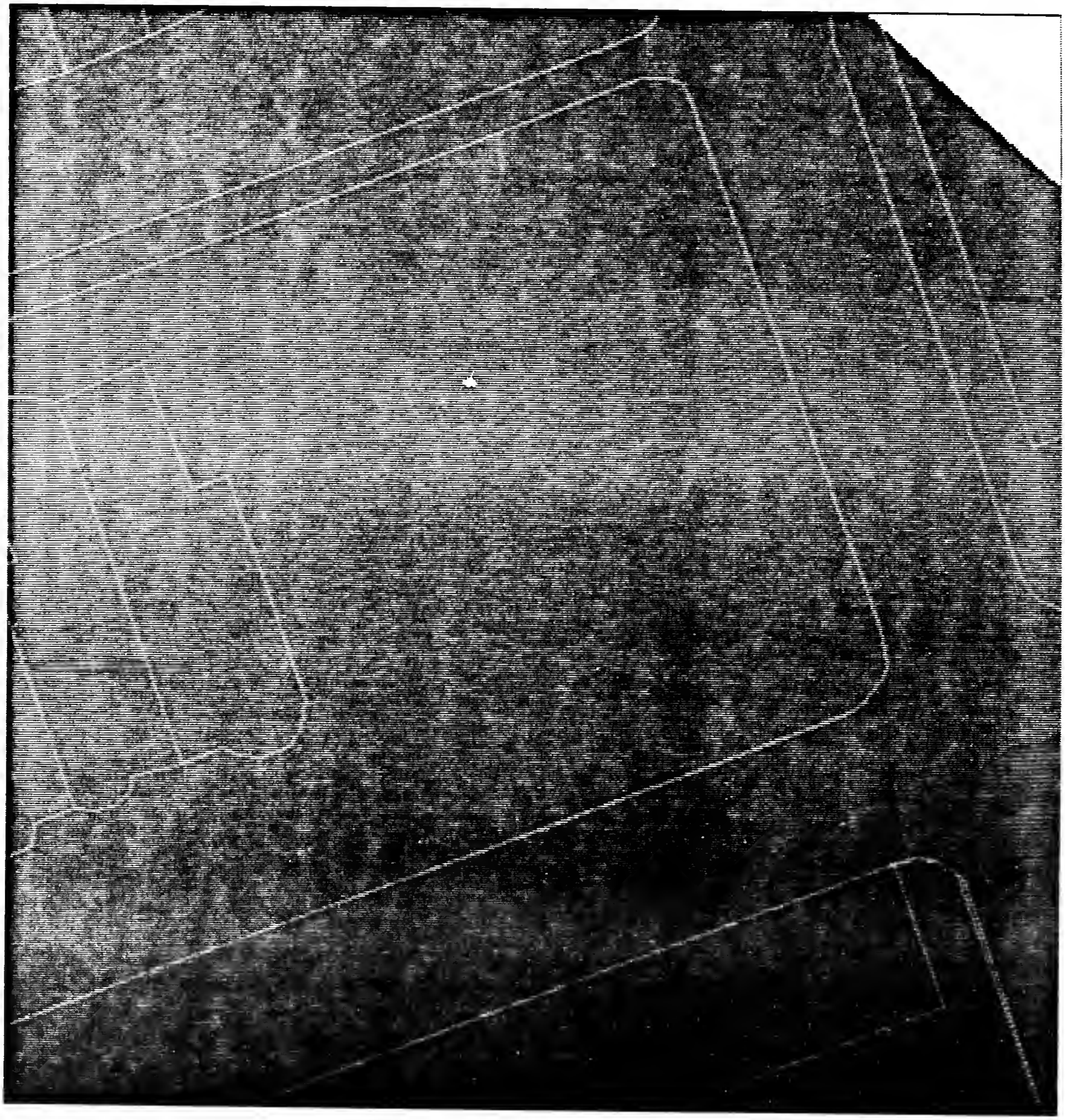
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

14 December 8:00am



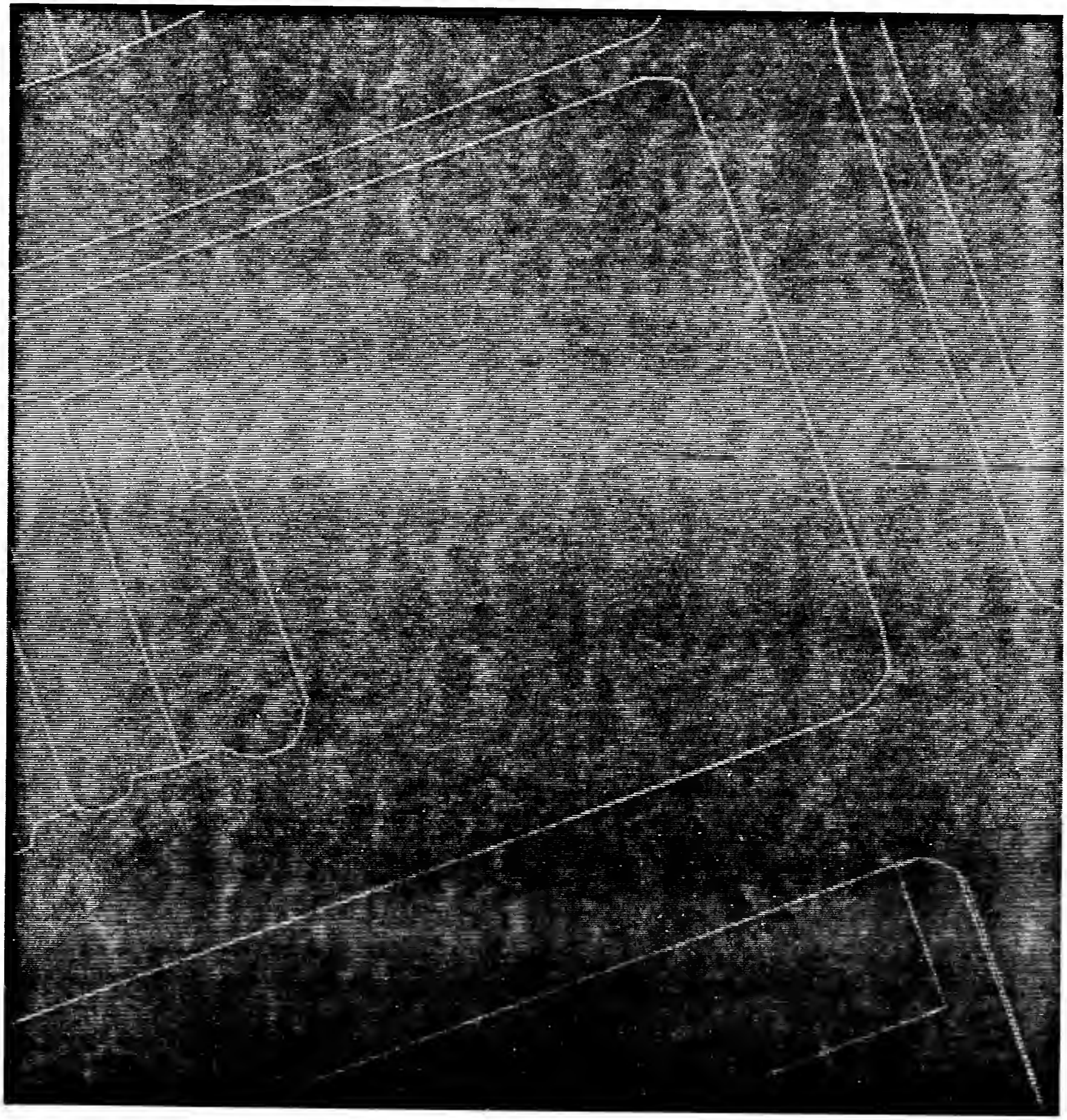
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

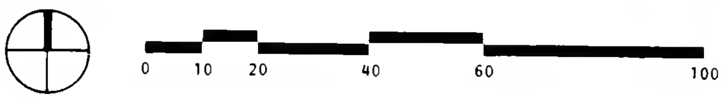
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

14 December 8:15am



Existing shadow

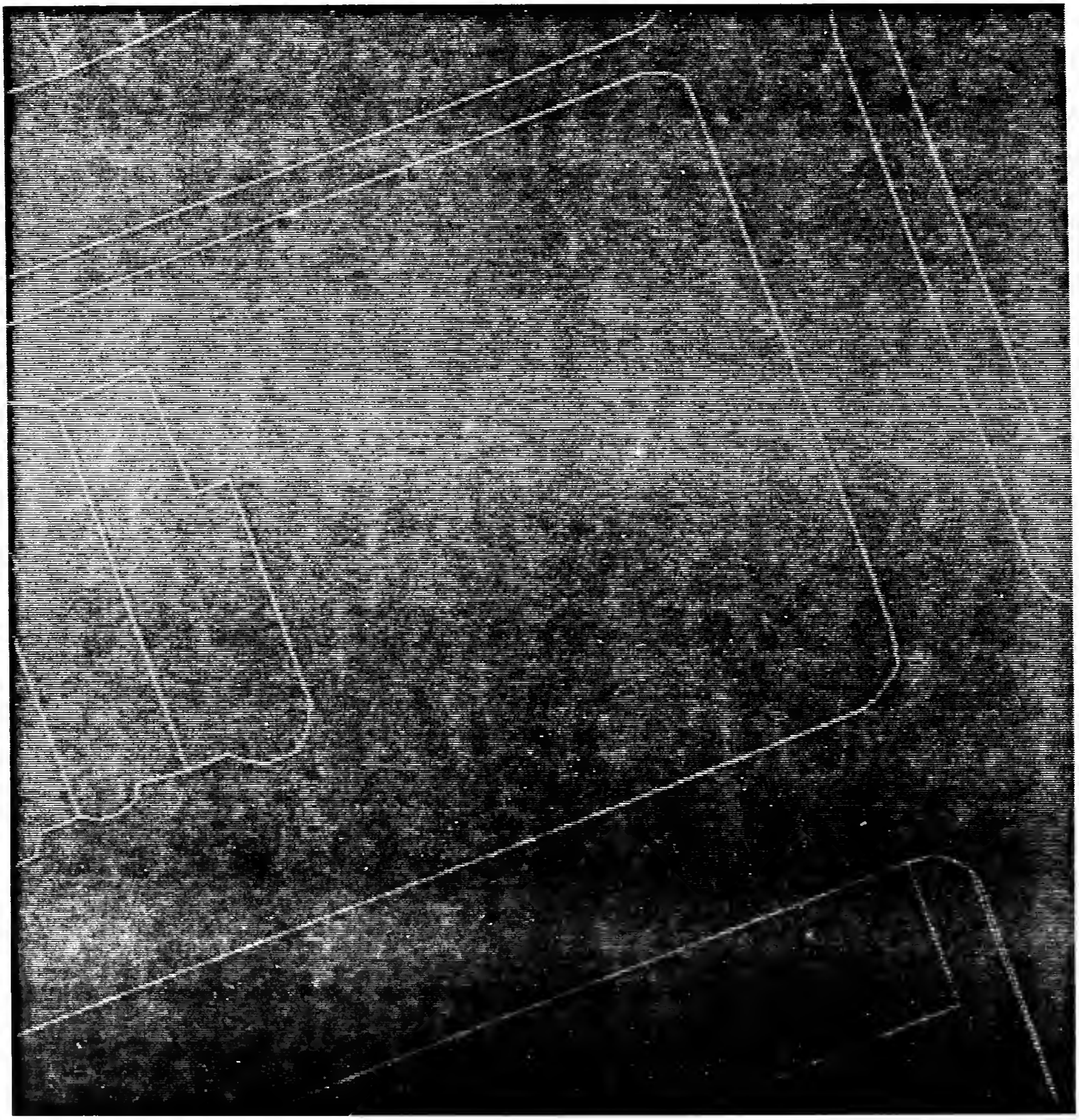
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

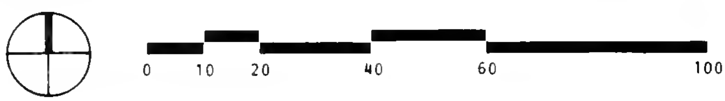
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

14 December 8:30am



Existing shadow

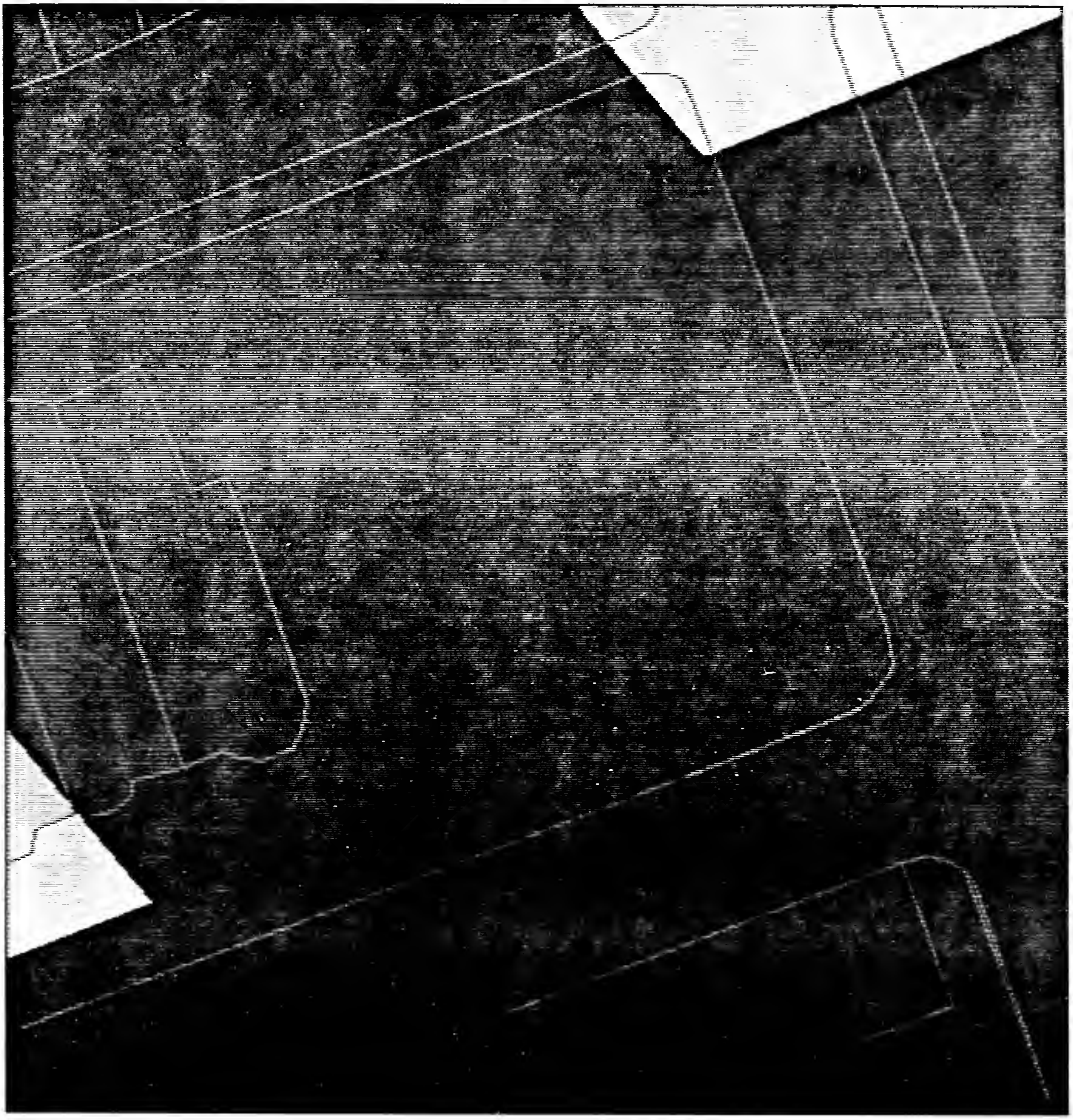
Incremental shadow
New England Life Project



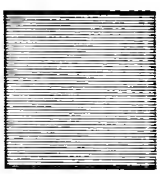
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

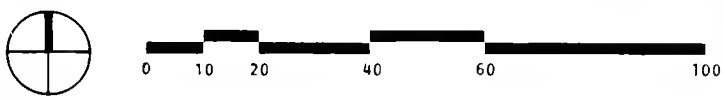
14 December 8:45am



Existing shadow



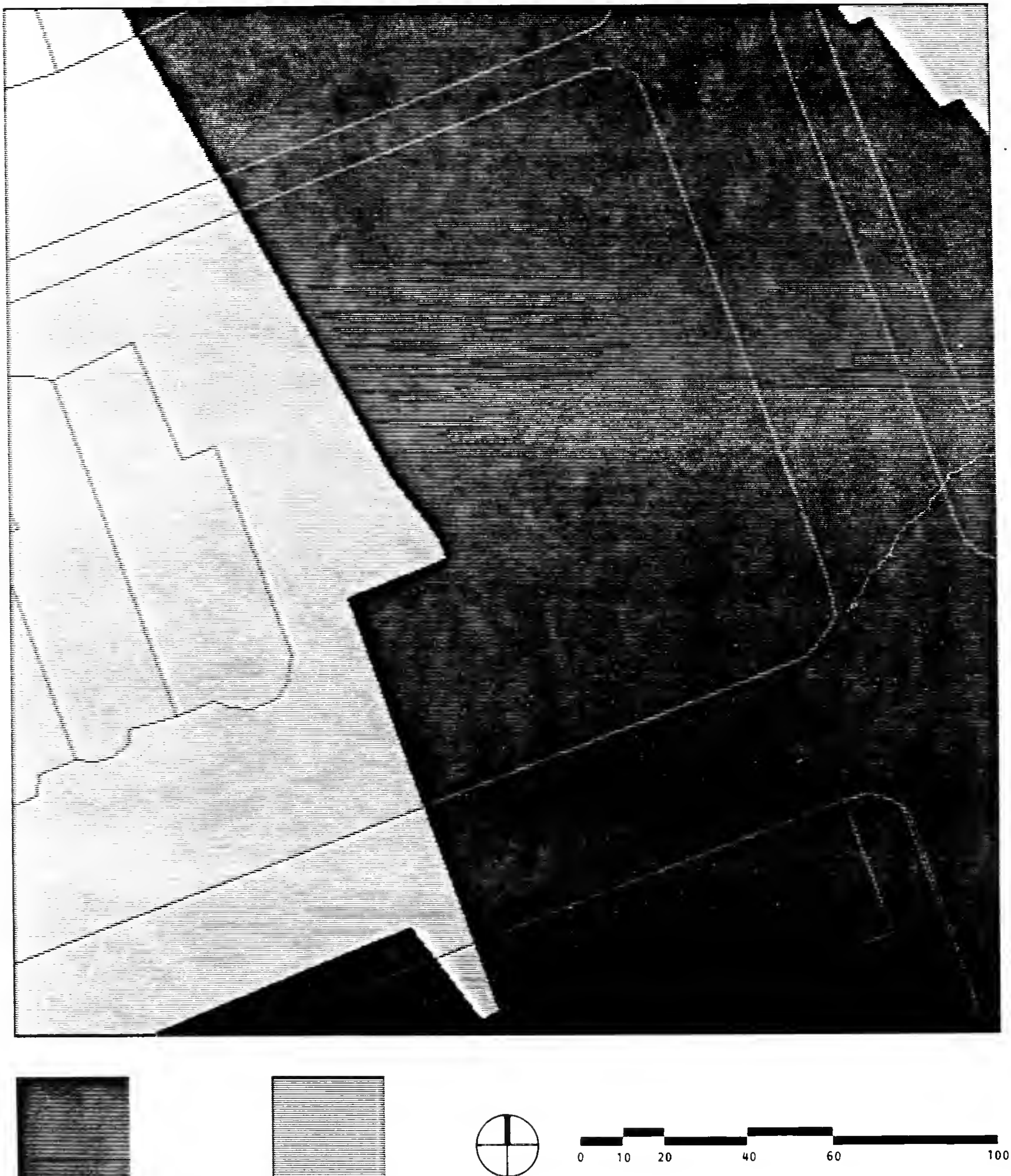
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

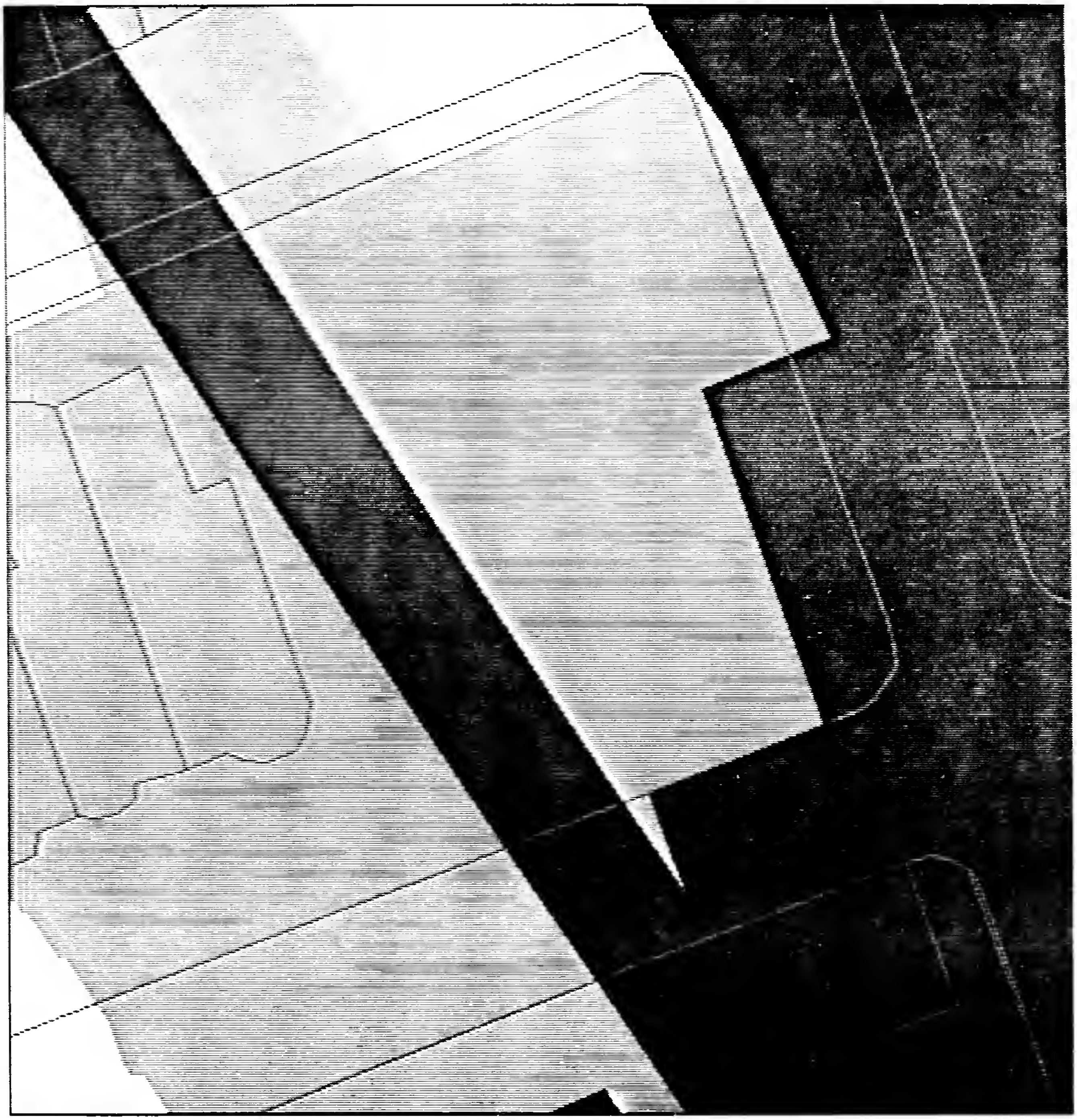
14 December 9:00am

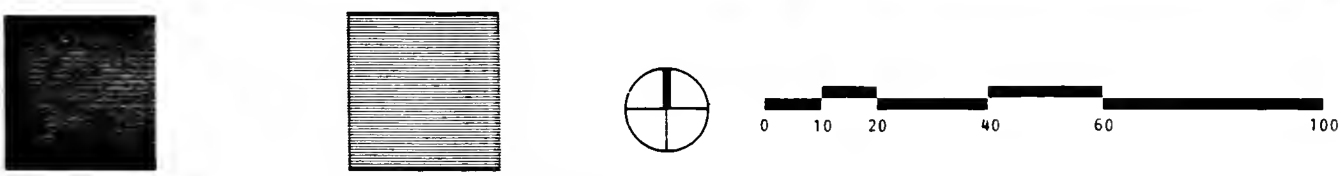


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

14 December 9:15am





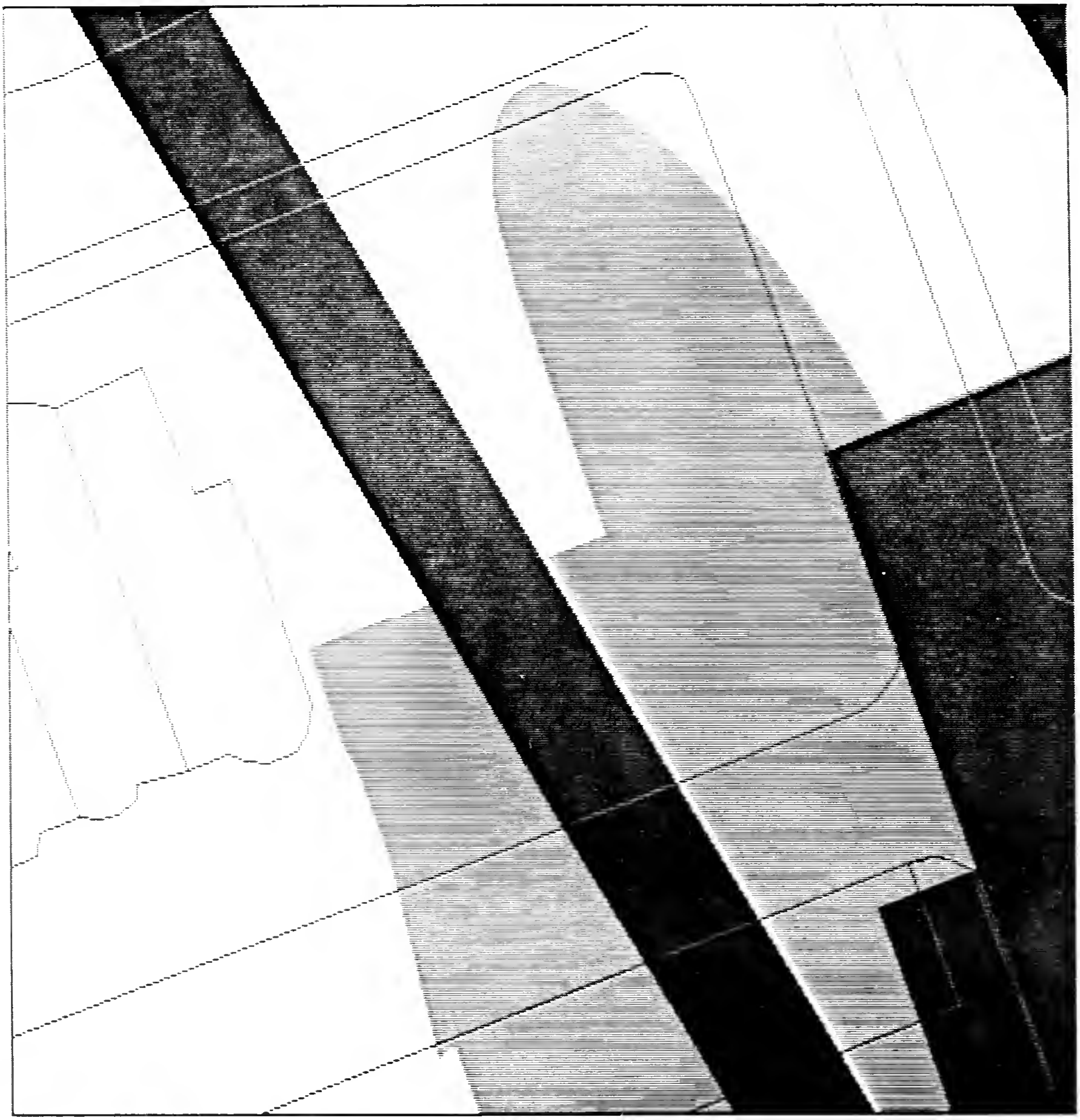
Existing shadow

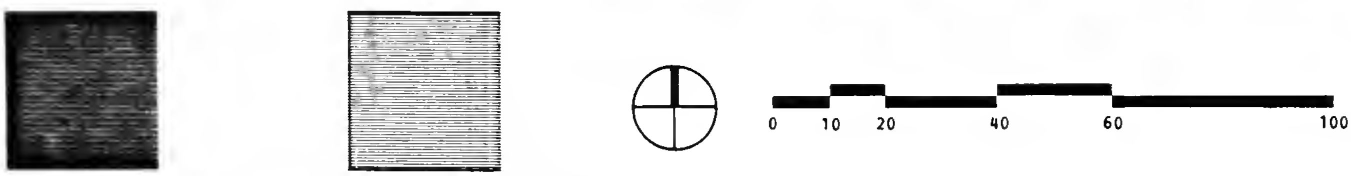
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

14 December 9:30am





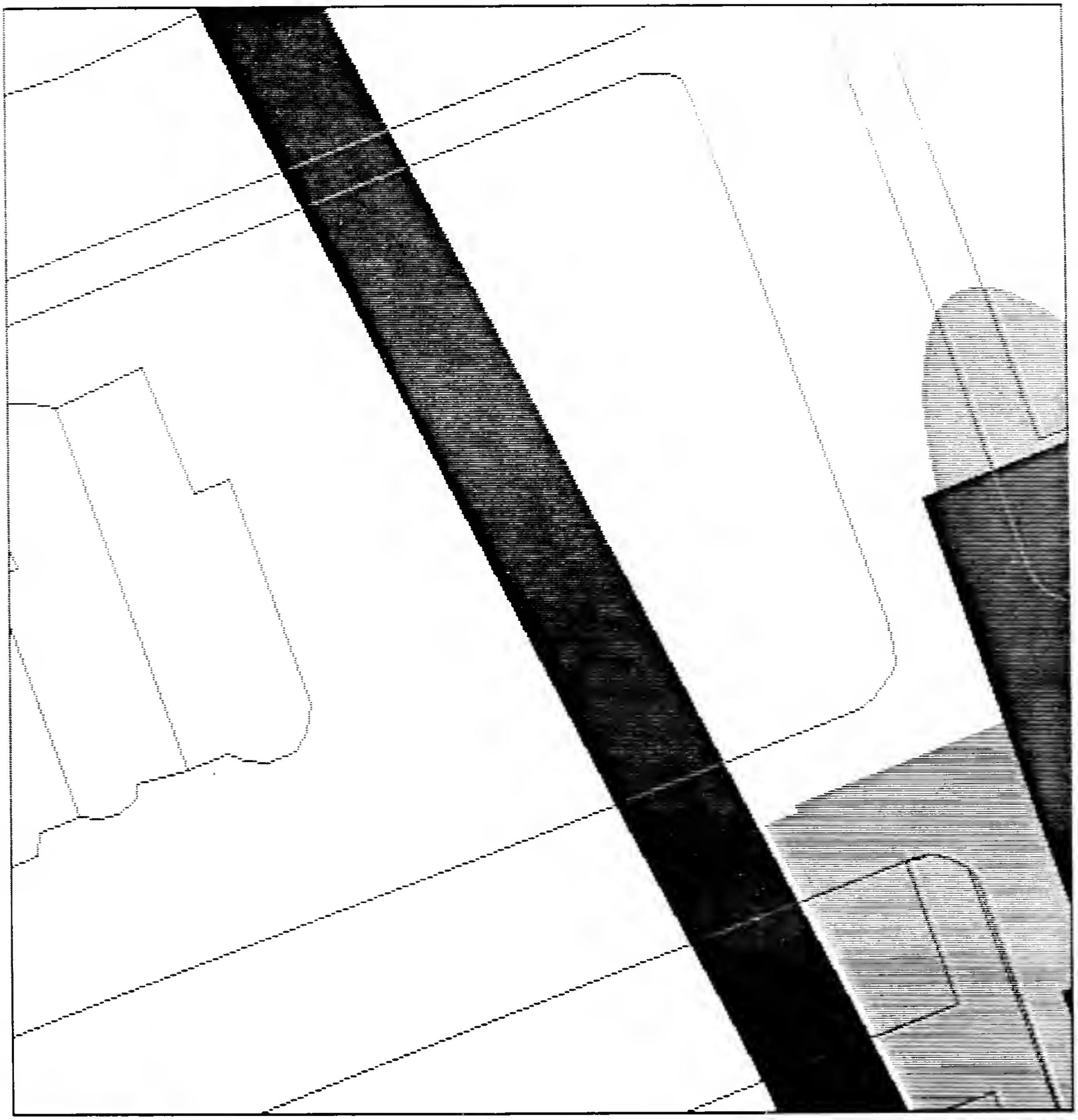
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

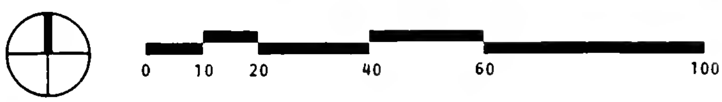
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

14 December 9:45am



Existing shadow

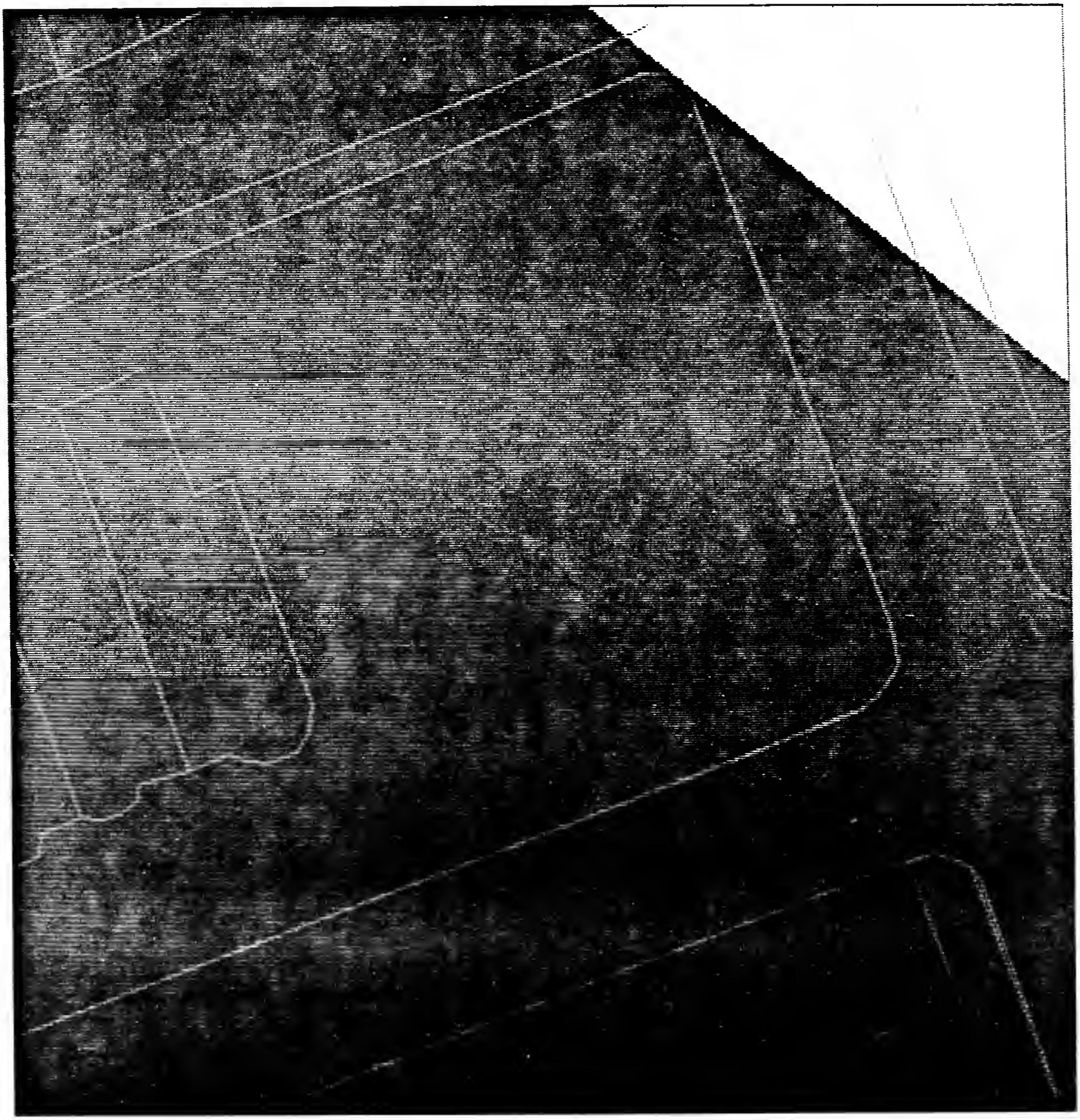
Incremental shadow
New England Life Project

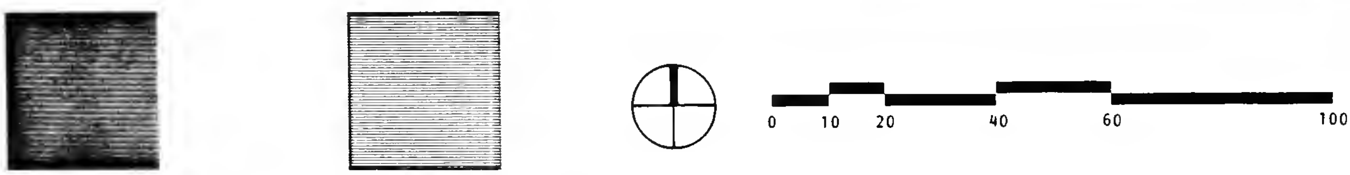


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

21 December 7:45am





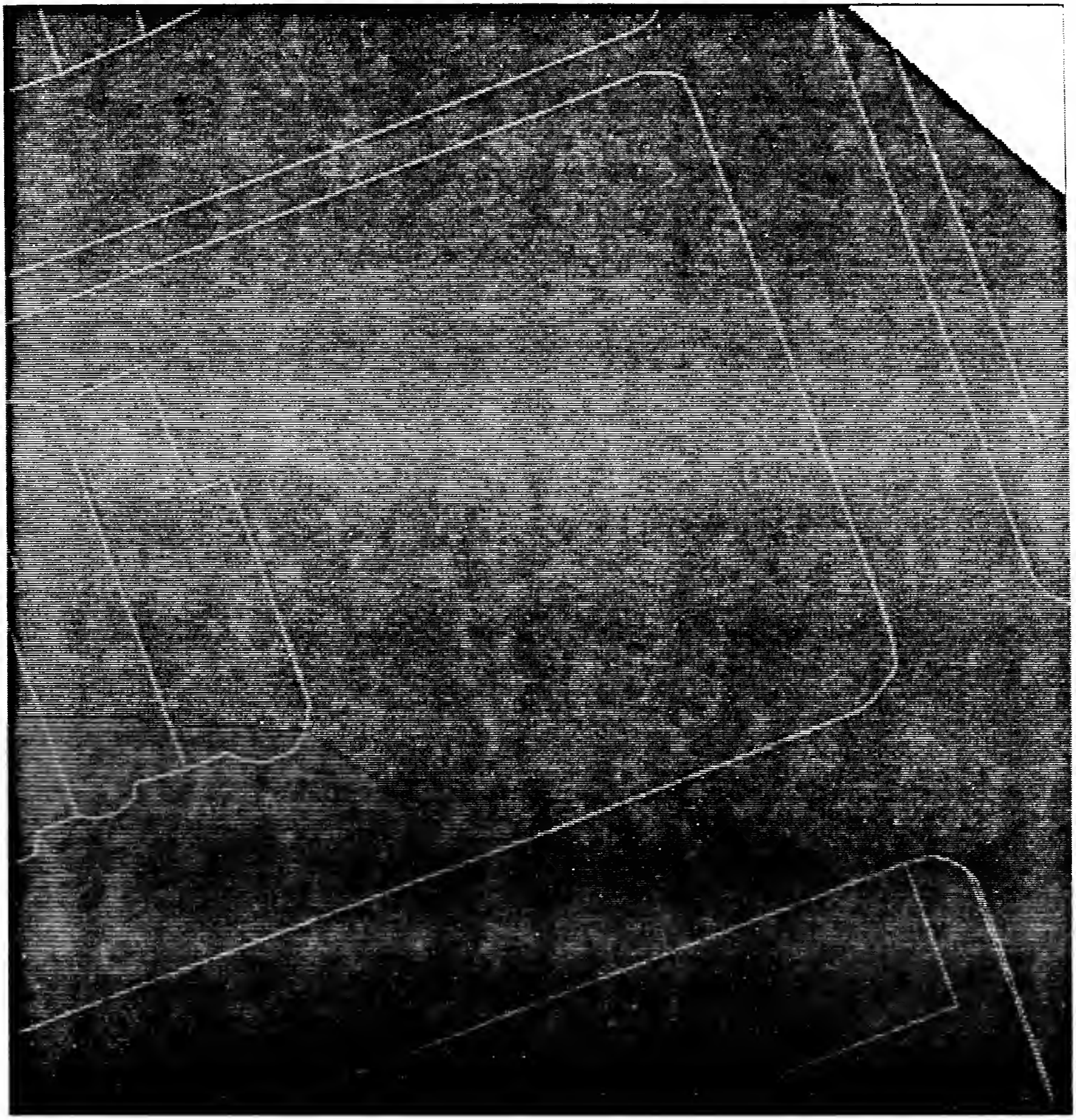
Existing shadow

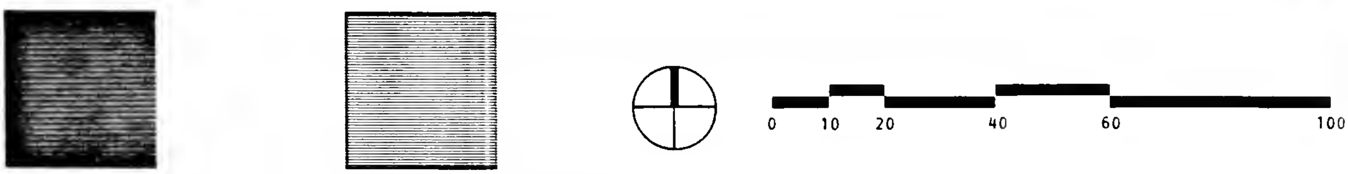
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

21 December 8:00am





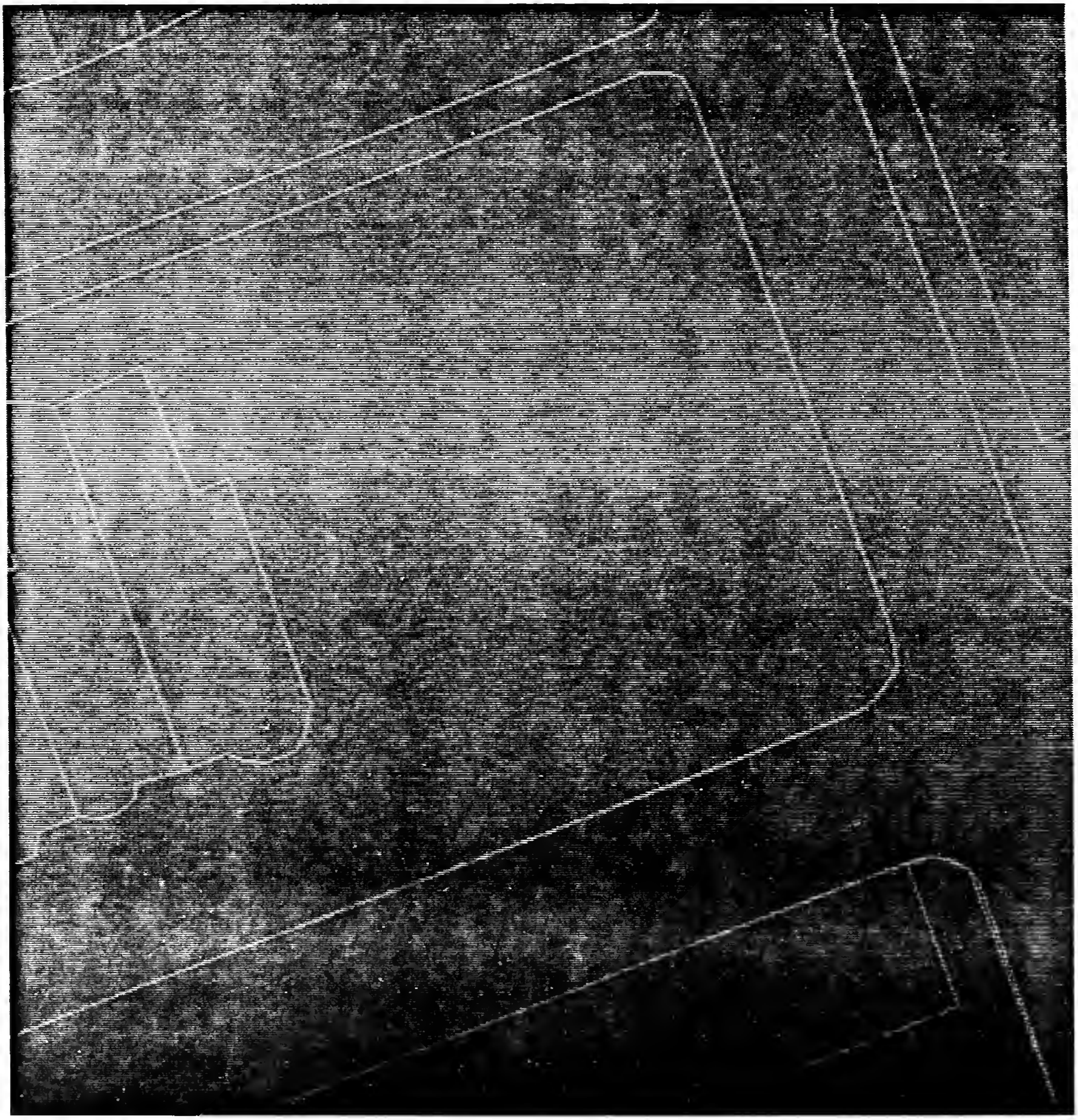
Existing shadow

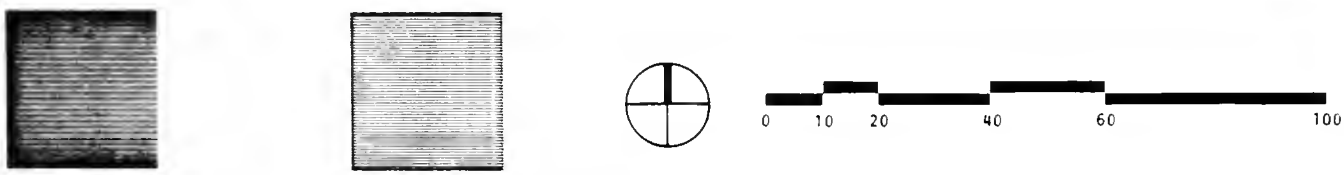
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

21 December 8:15am





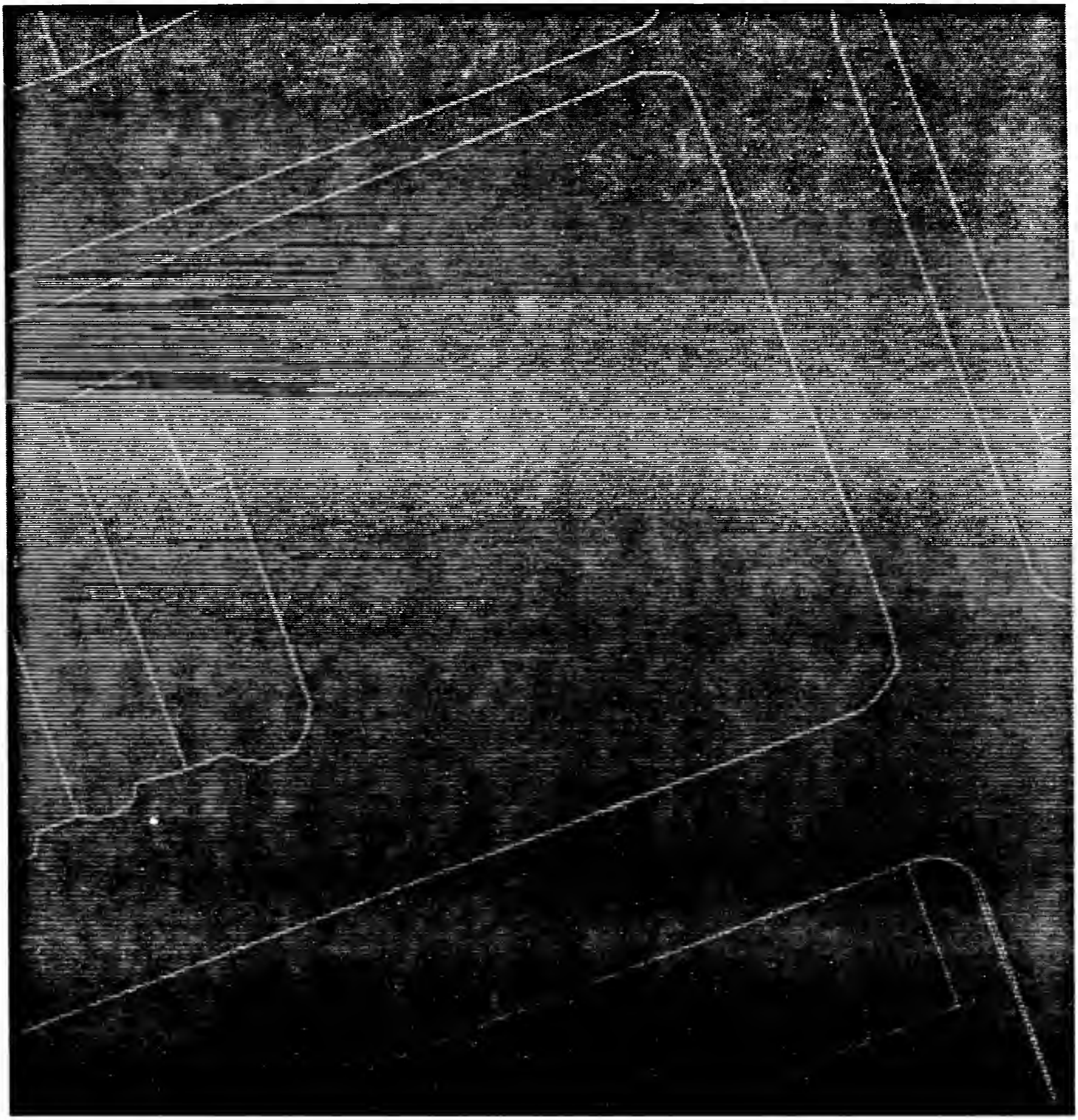
Existing shadow

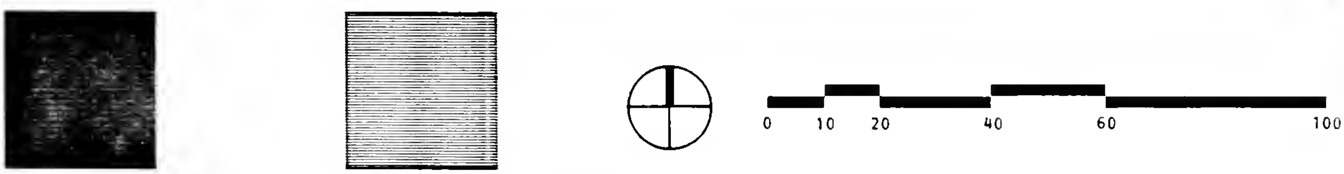
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

21 December 8:30am





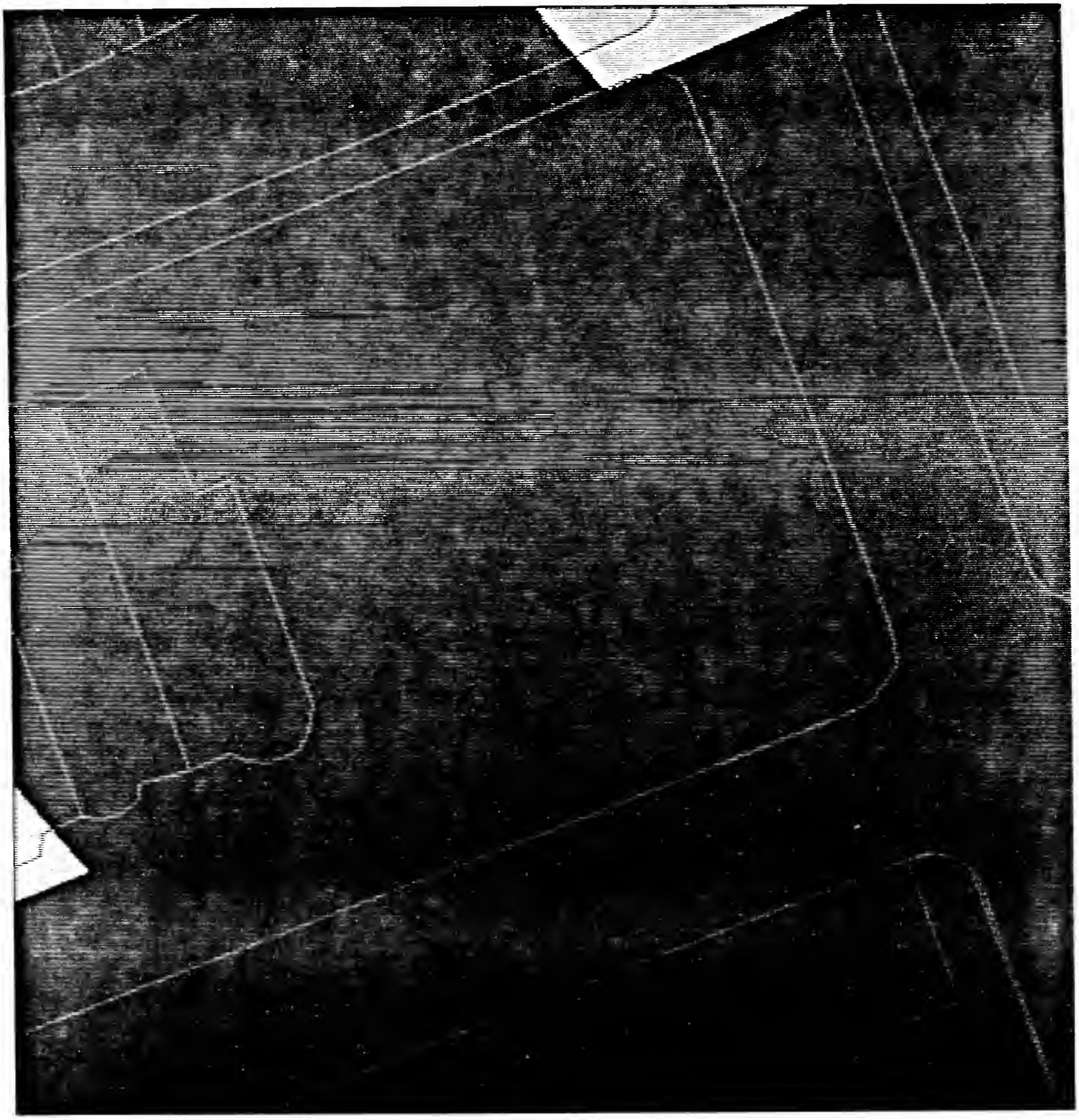
Existing shadow

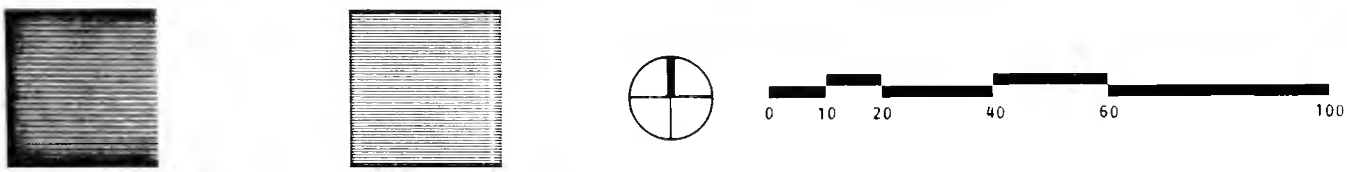
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

21 December 8:45am





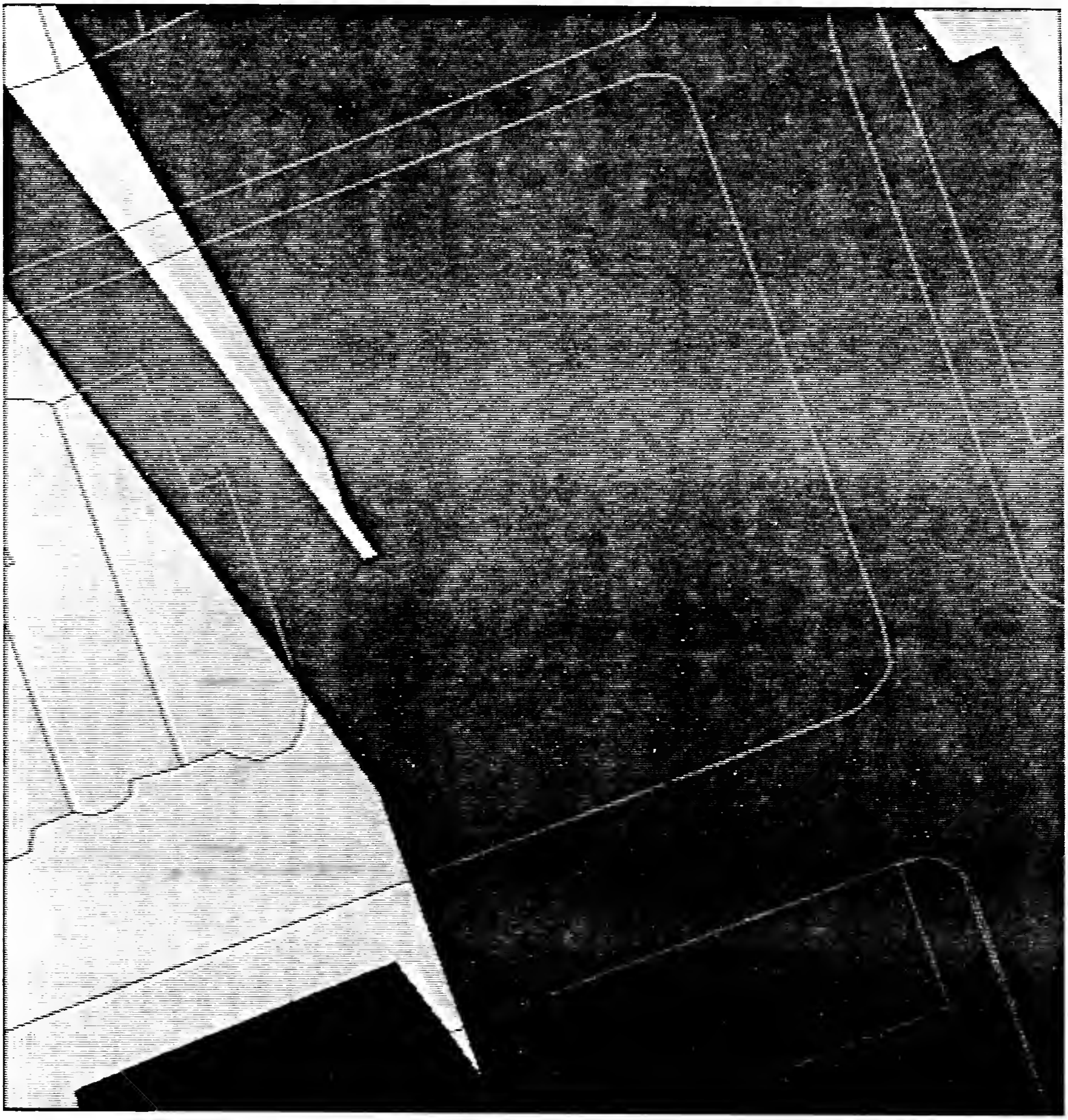
Existing shadow

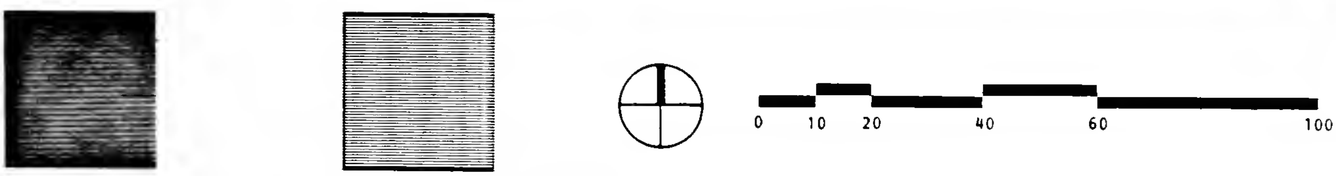
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

21 December 9:00am





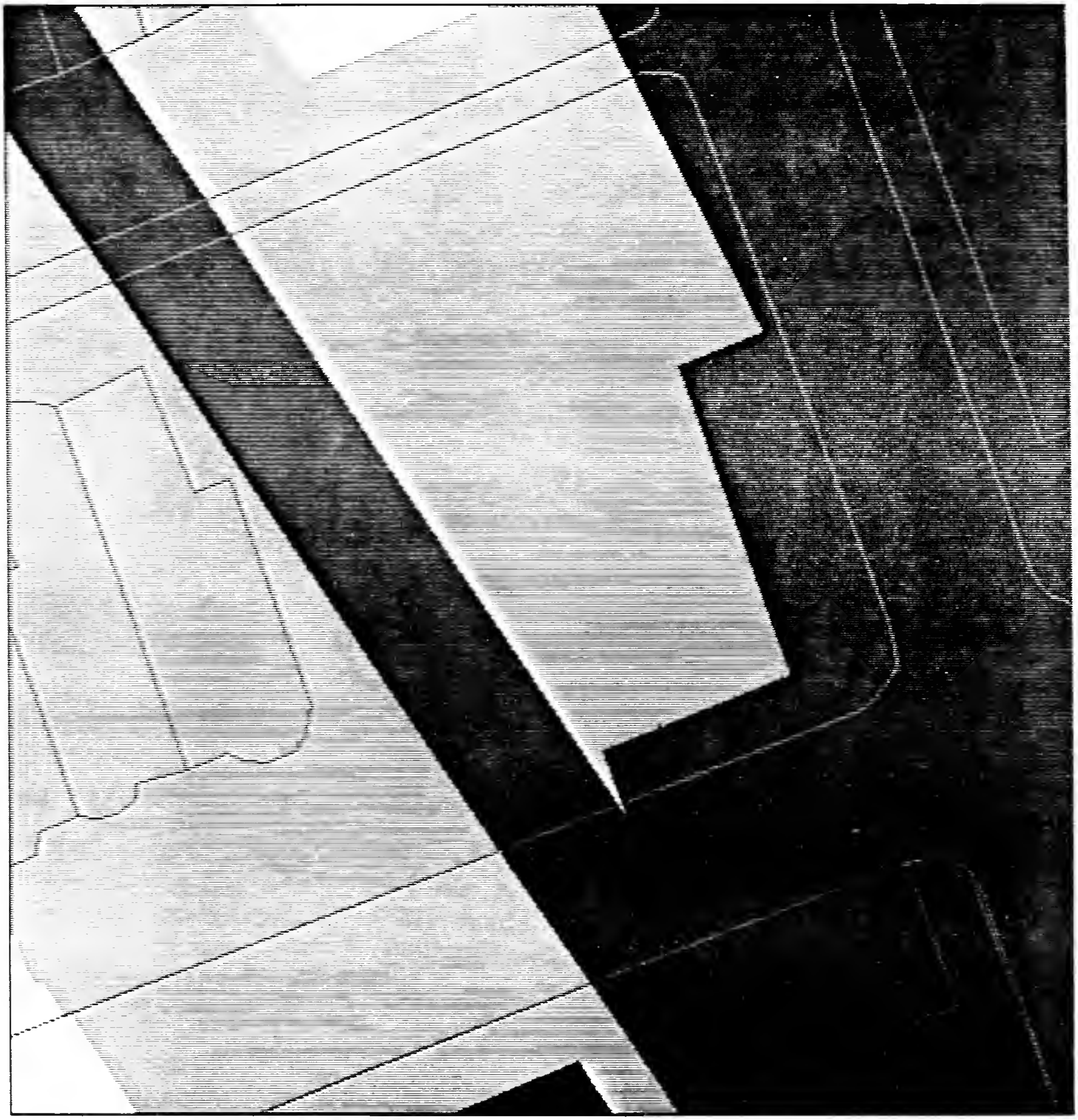
Existing shadow

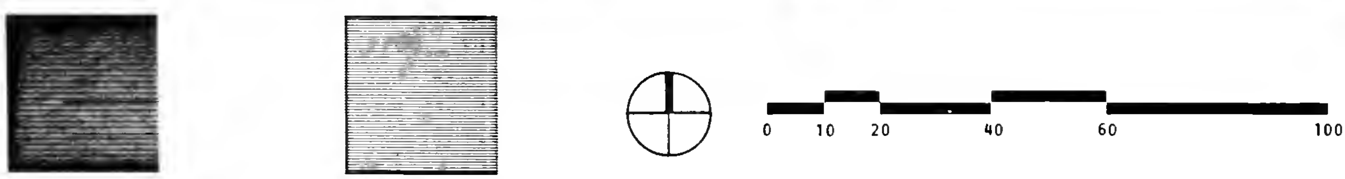
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

21 December 9:15am





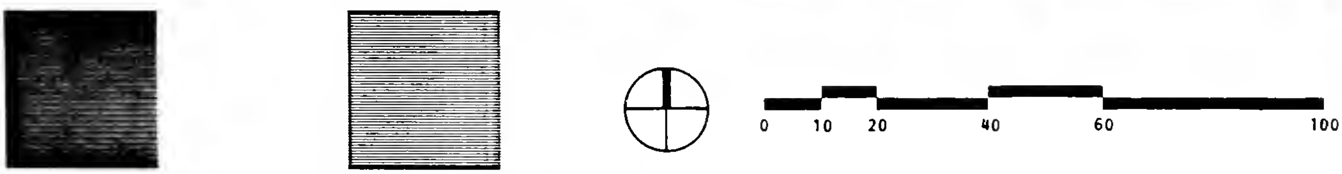
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

21 December 9:30am



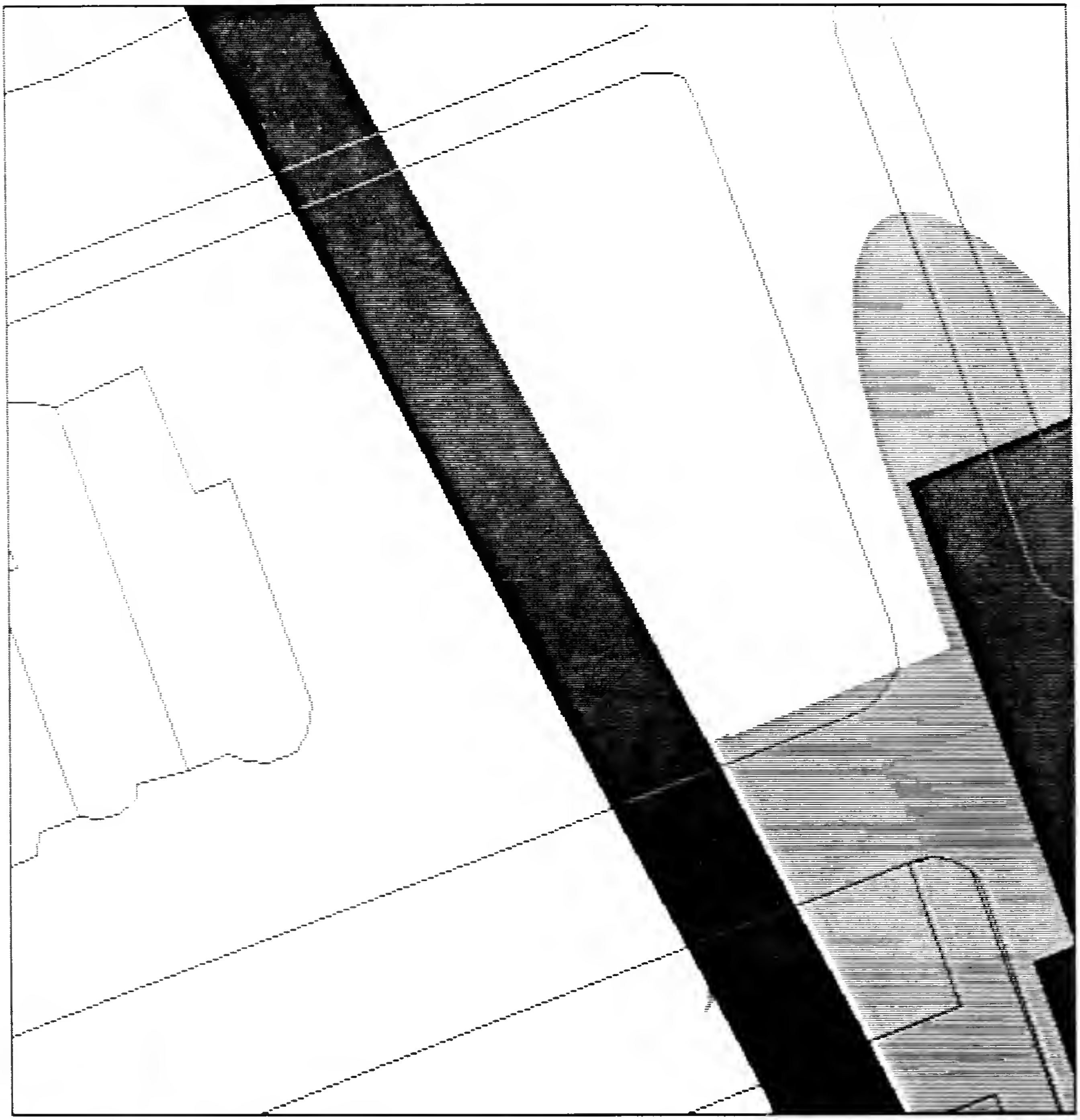
Existing shadow

Incremental shadow
New England Life Project

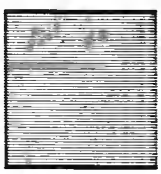
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

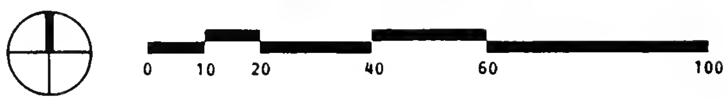
21 December 9:45am



Existing shadow



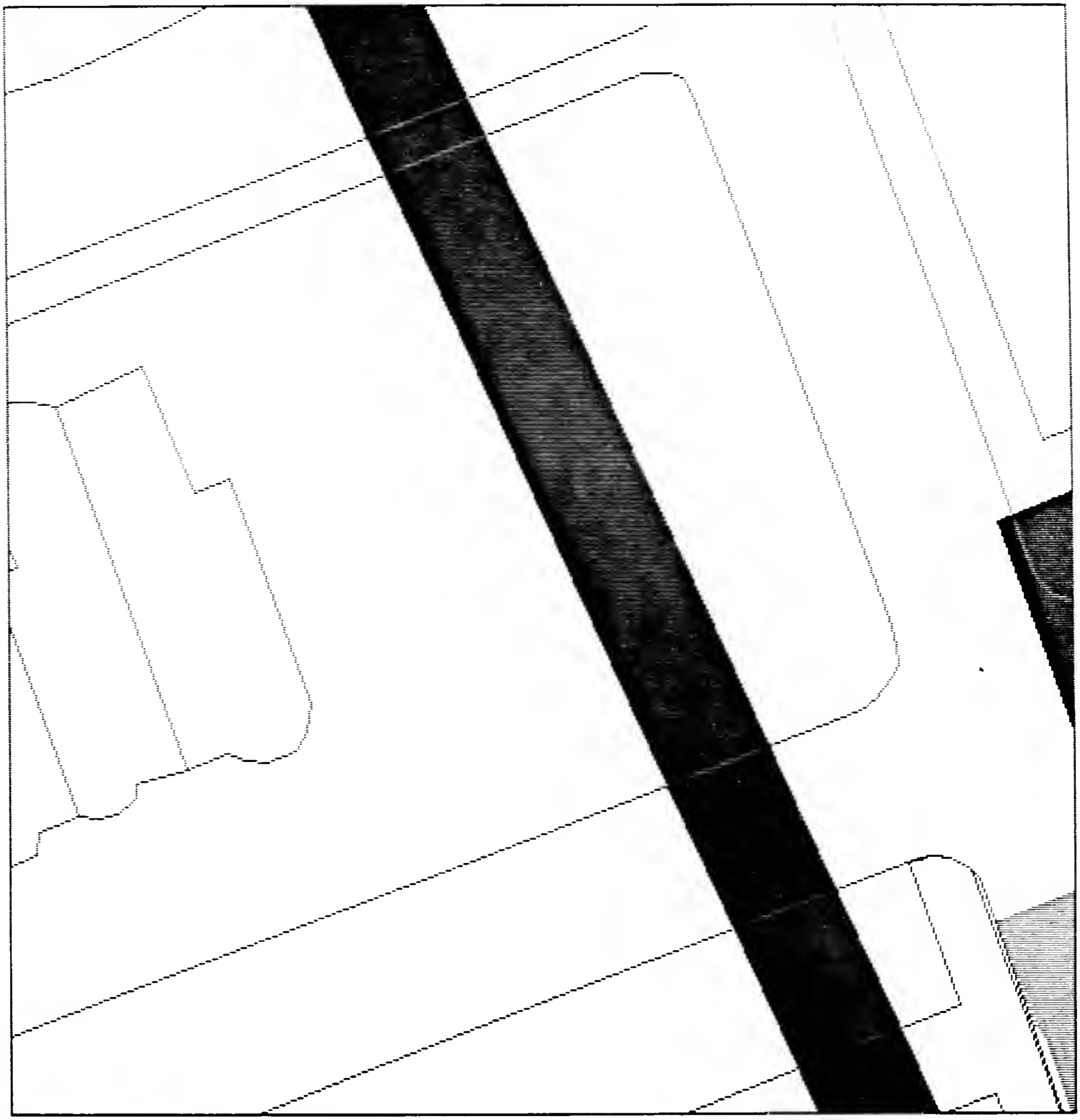
Incremental shadow
New England Life Project

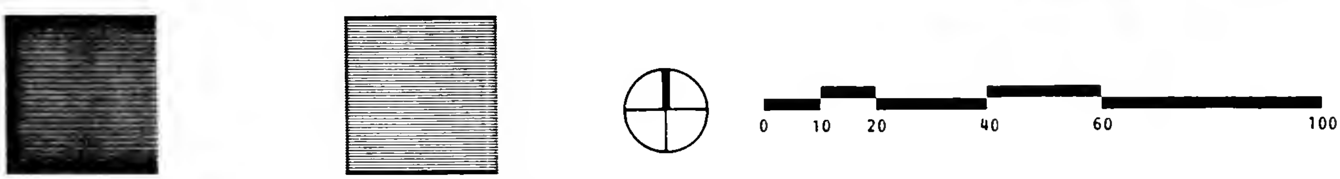


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

21 December 10:00am





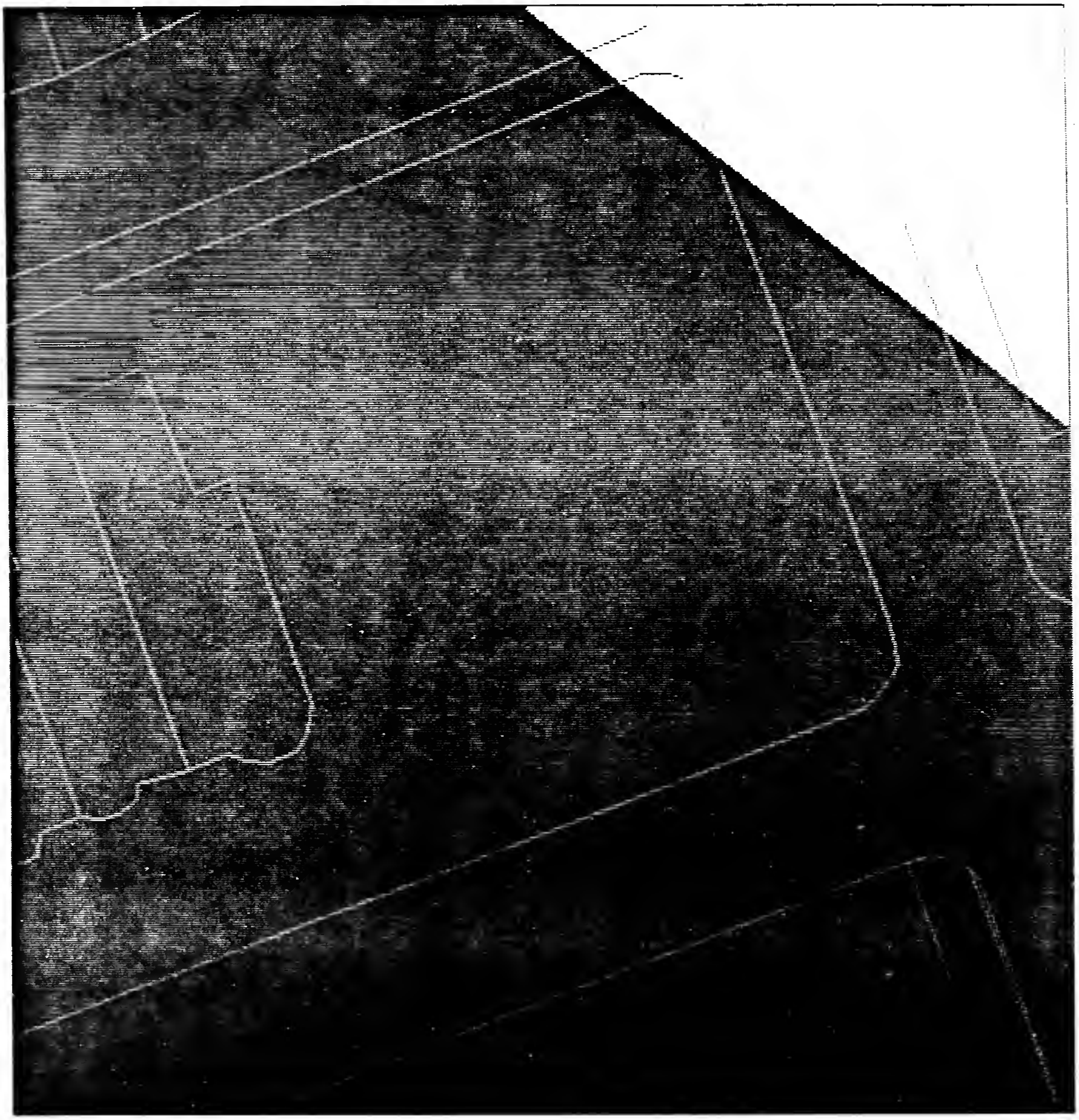
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

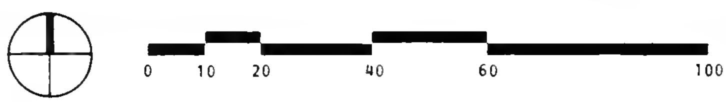
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

28 December 7:45am



Existing shadow

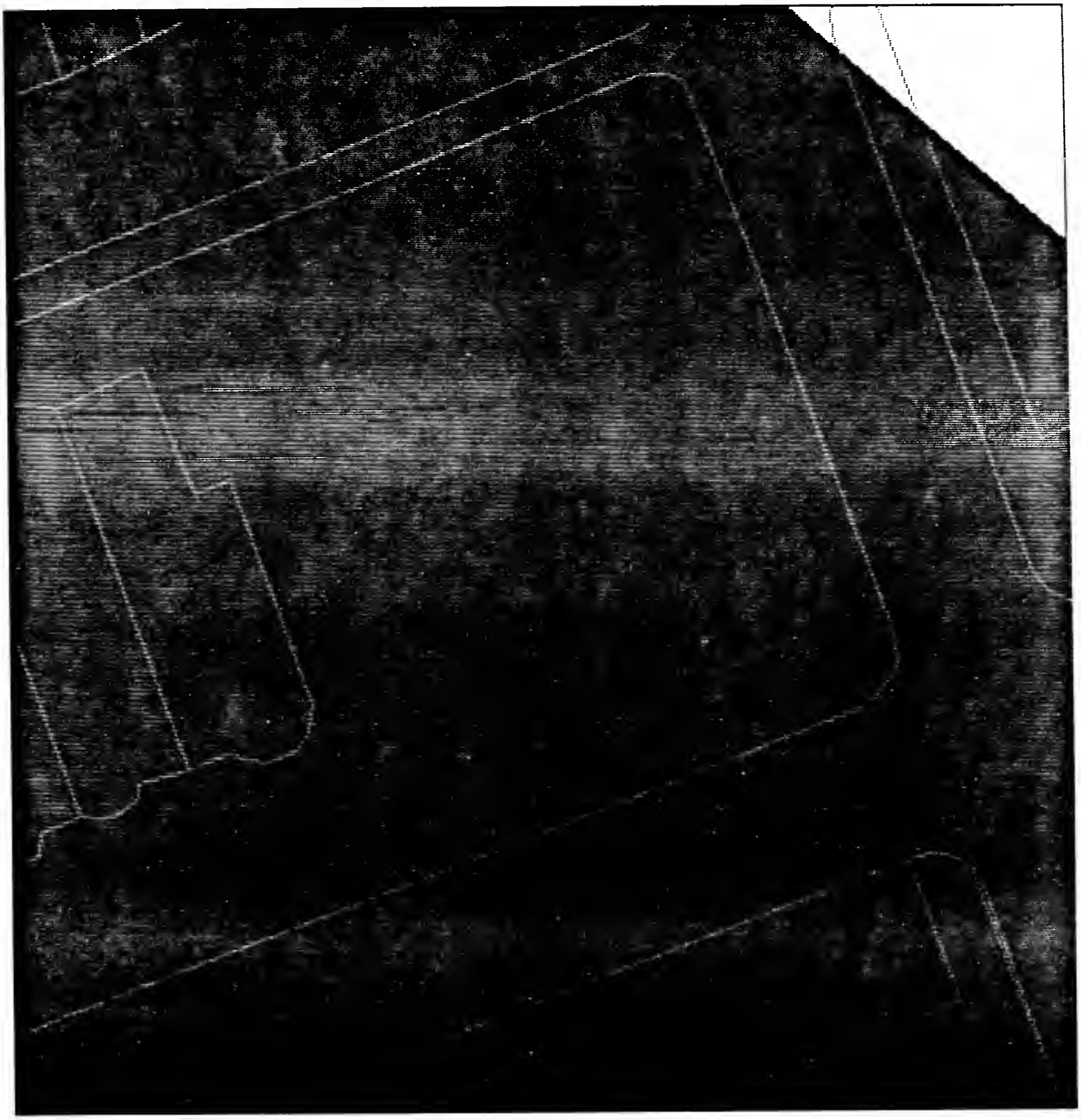
Incremental shadow
New England Life Project

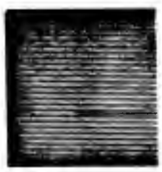


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

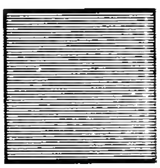
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

28 December 8:00am

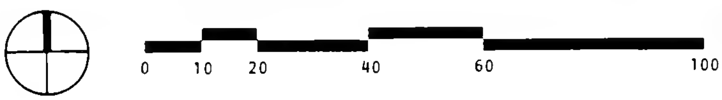




Existing shadow



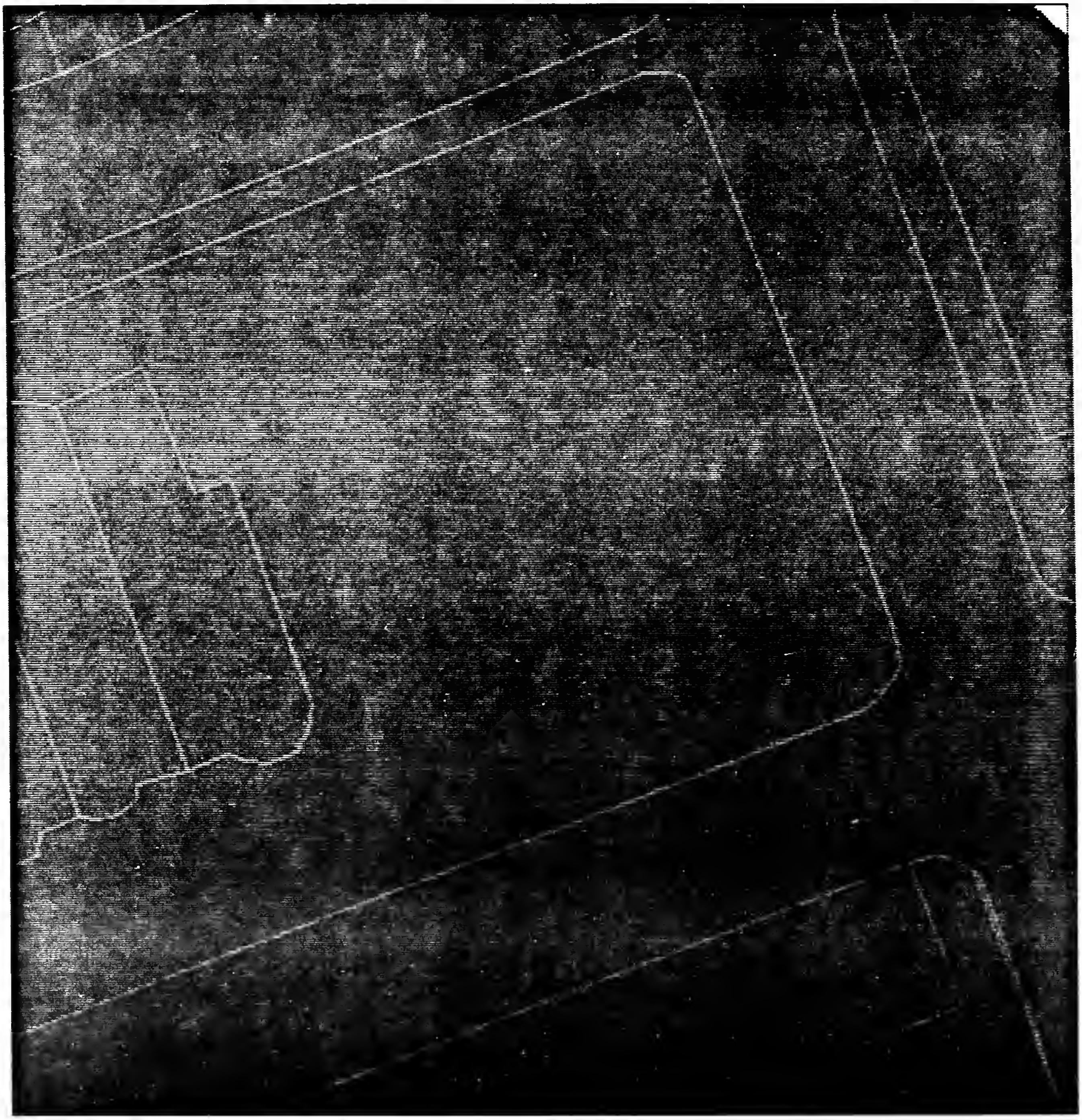
Incremental shadow
New England Life Project

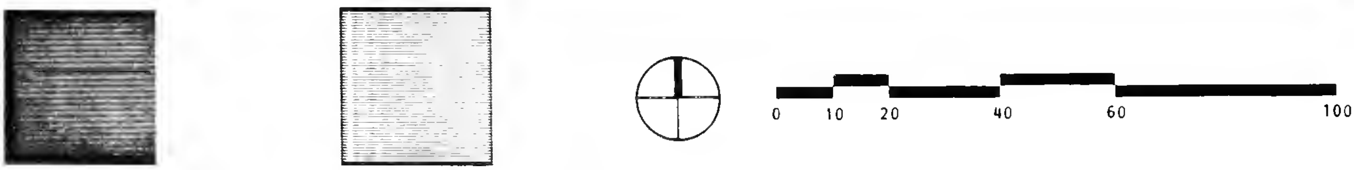


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

28 December 8:15am





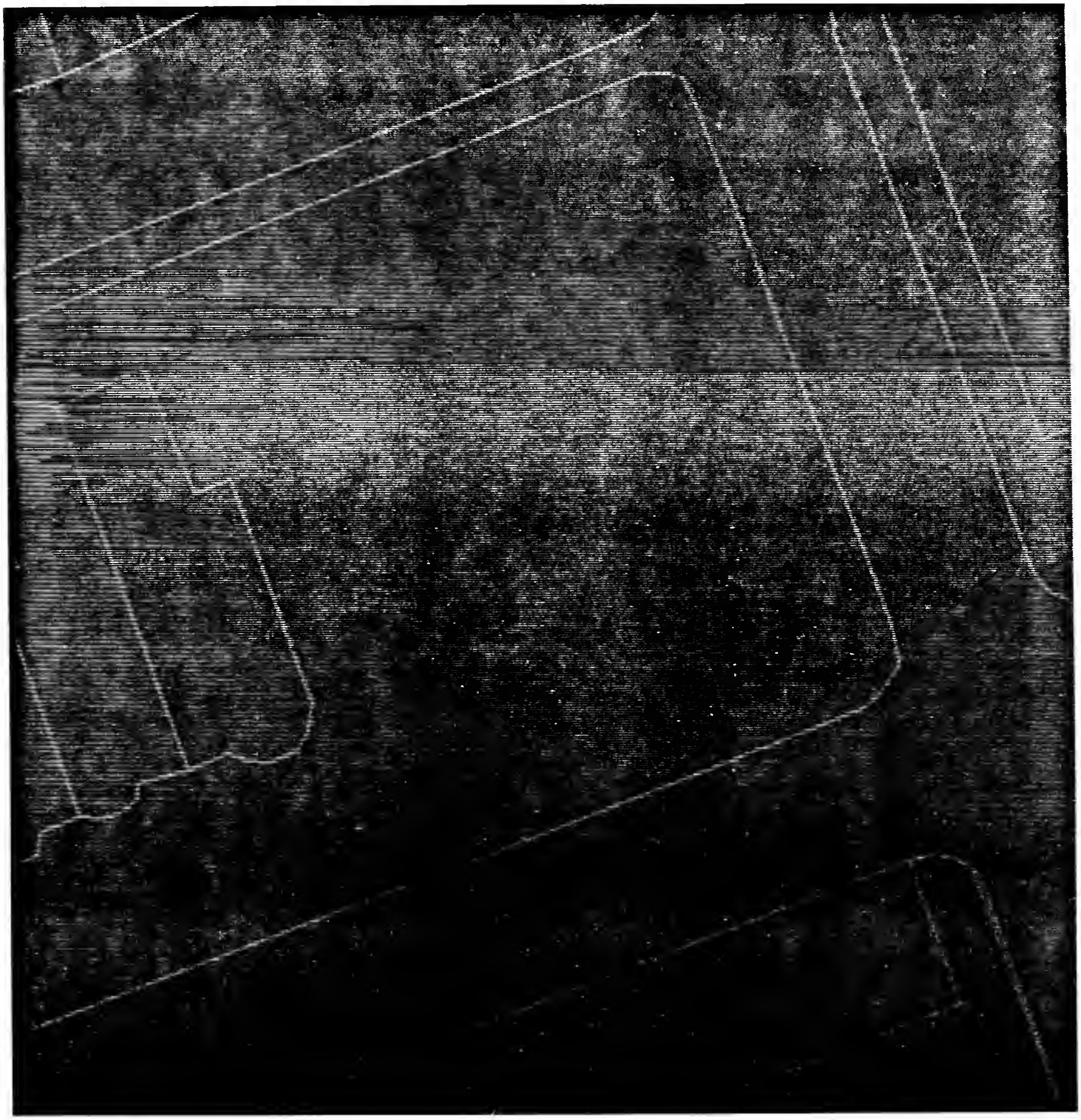
Existing shadow

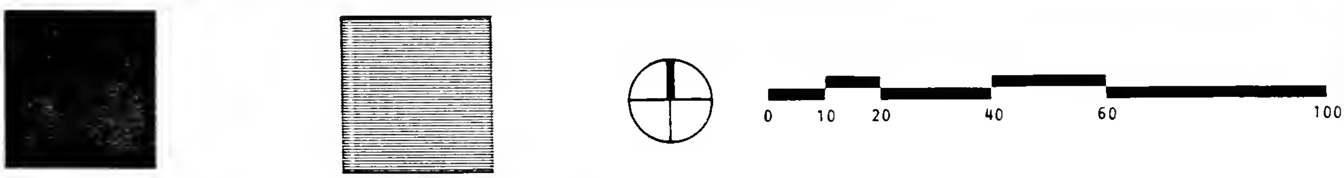
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

28 December 8:30am





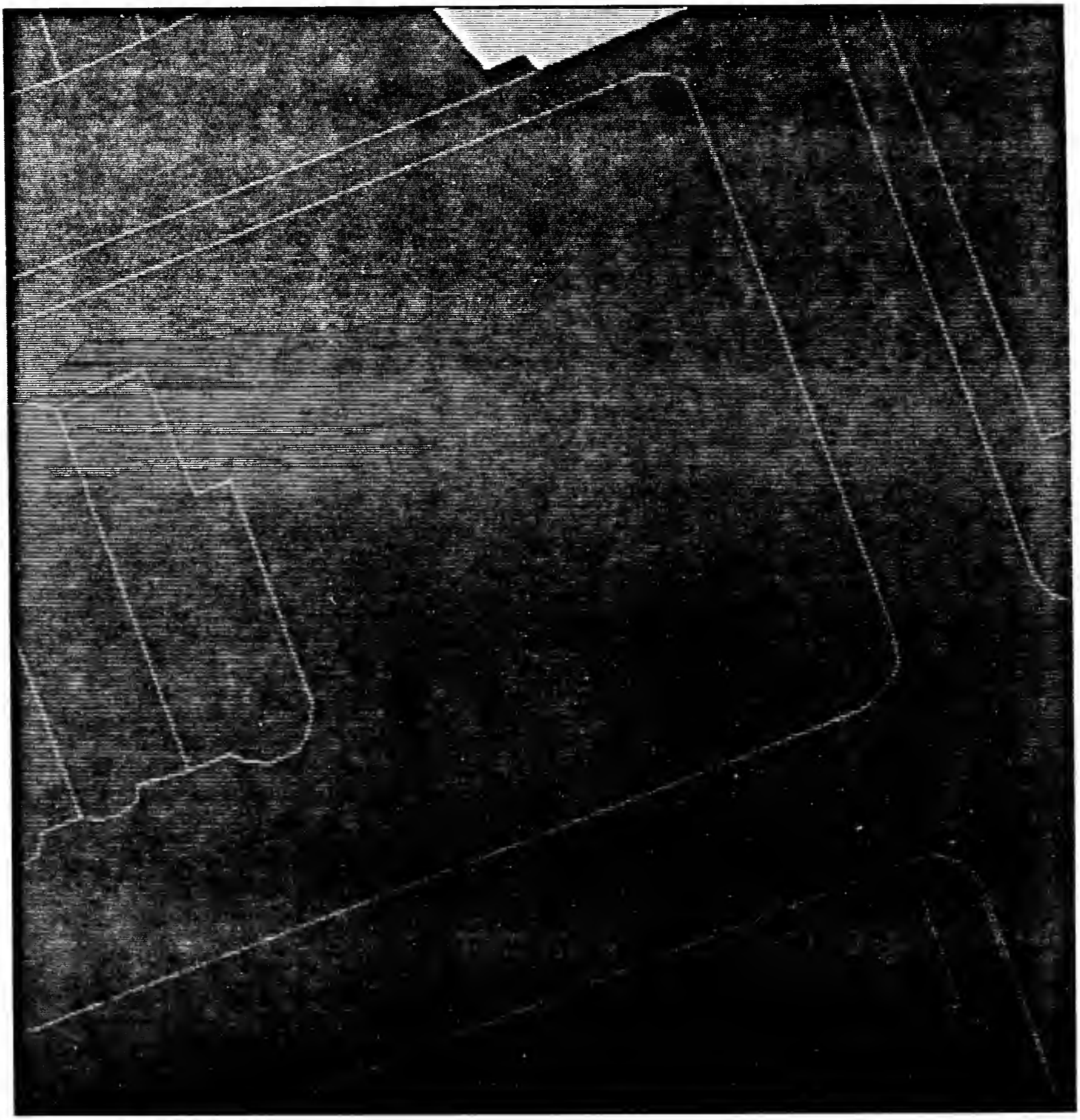
Existing shadow

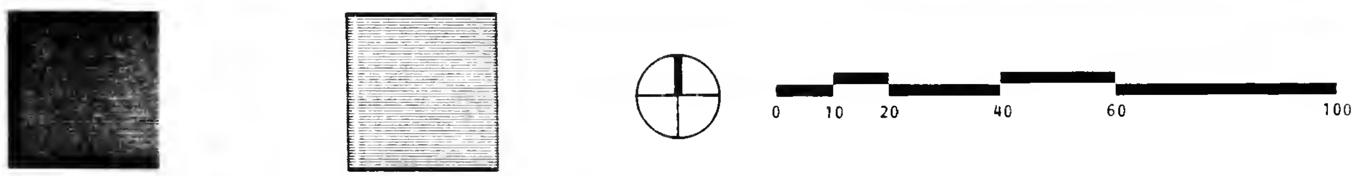
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

28 December 8:45am





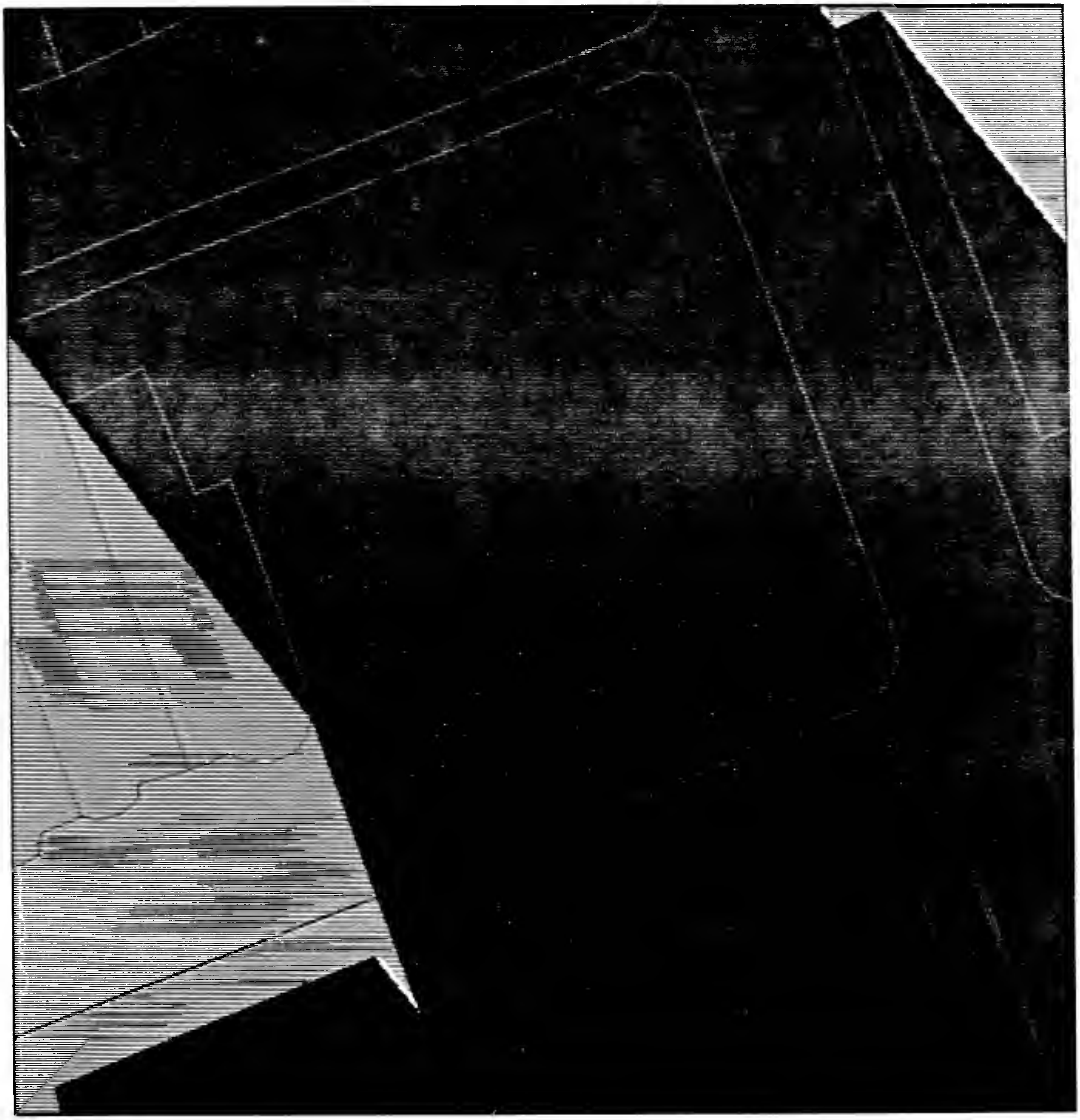
Existing shadow

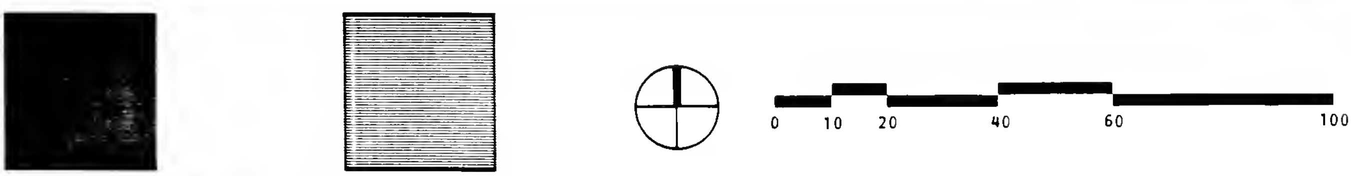
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

28 December 9:00am





Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

28 December 9:15am

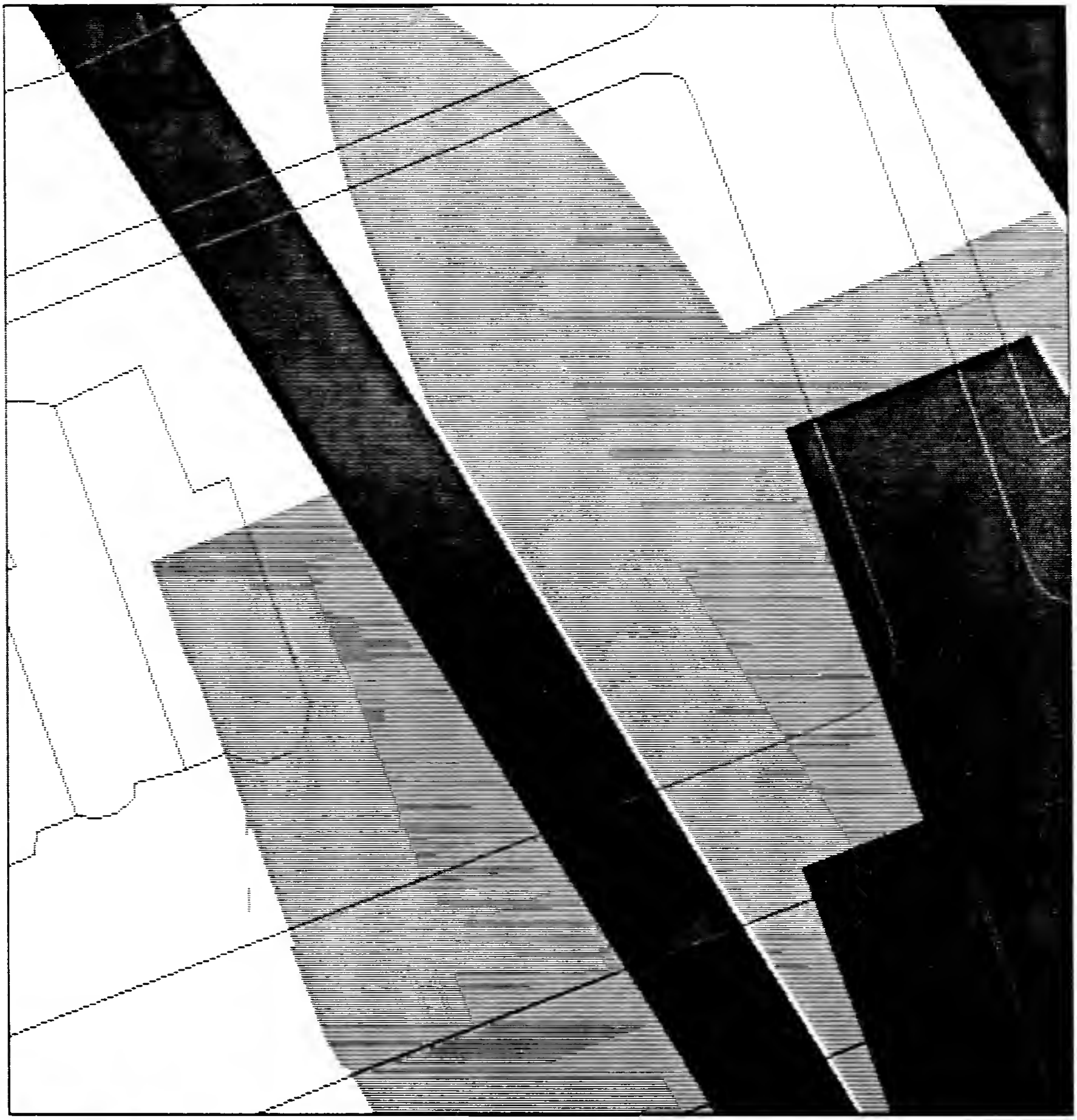
Existing shadow

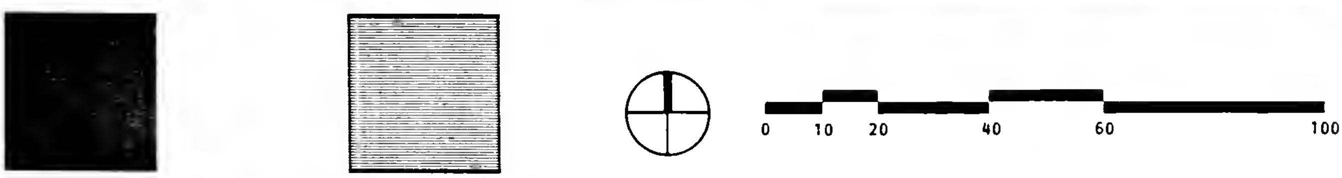
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

28 December 9:30am





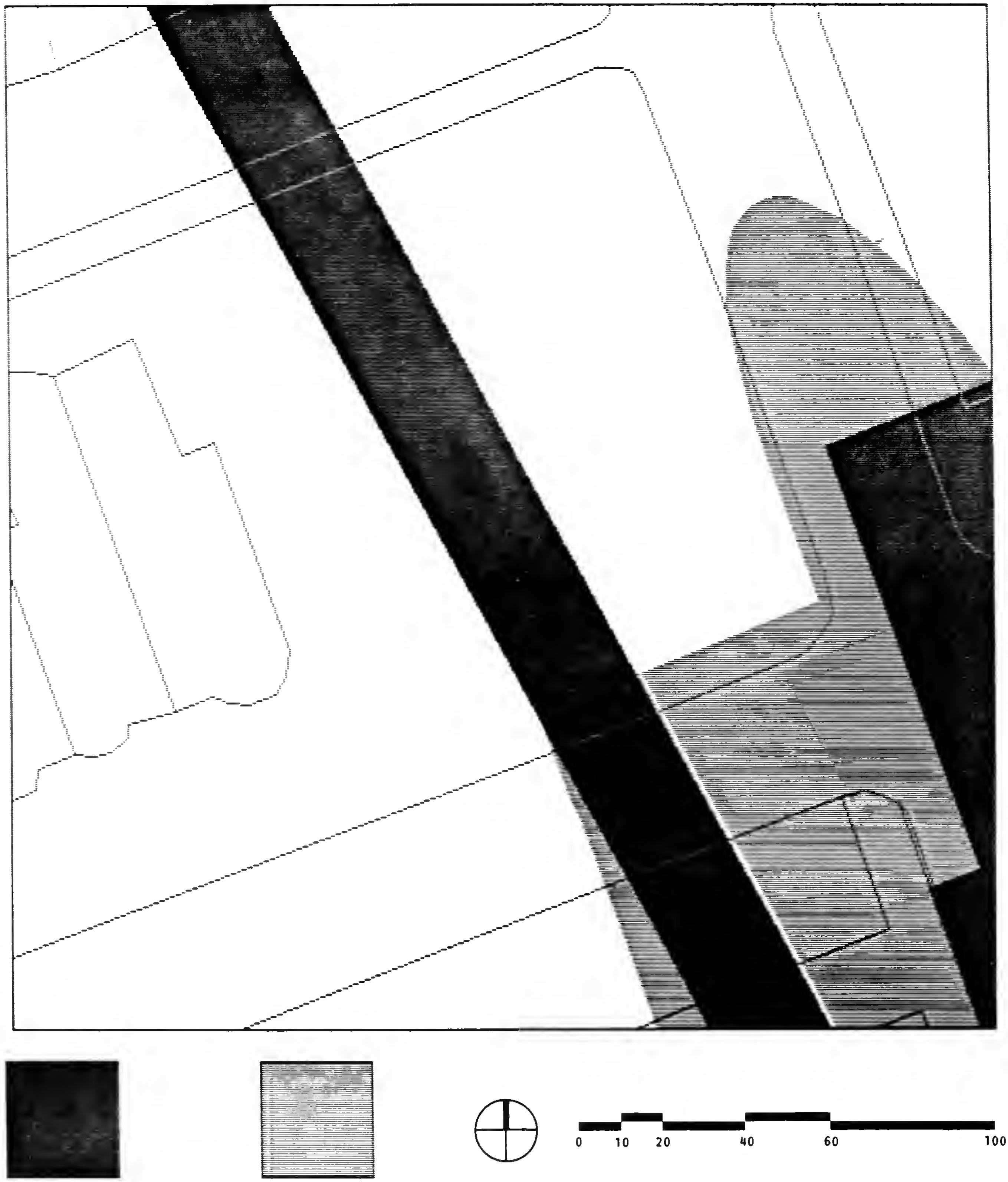
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

28 December 9:45am



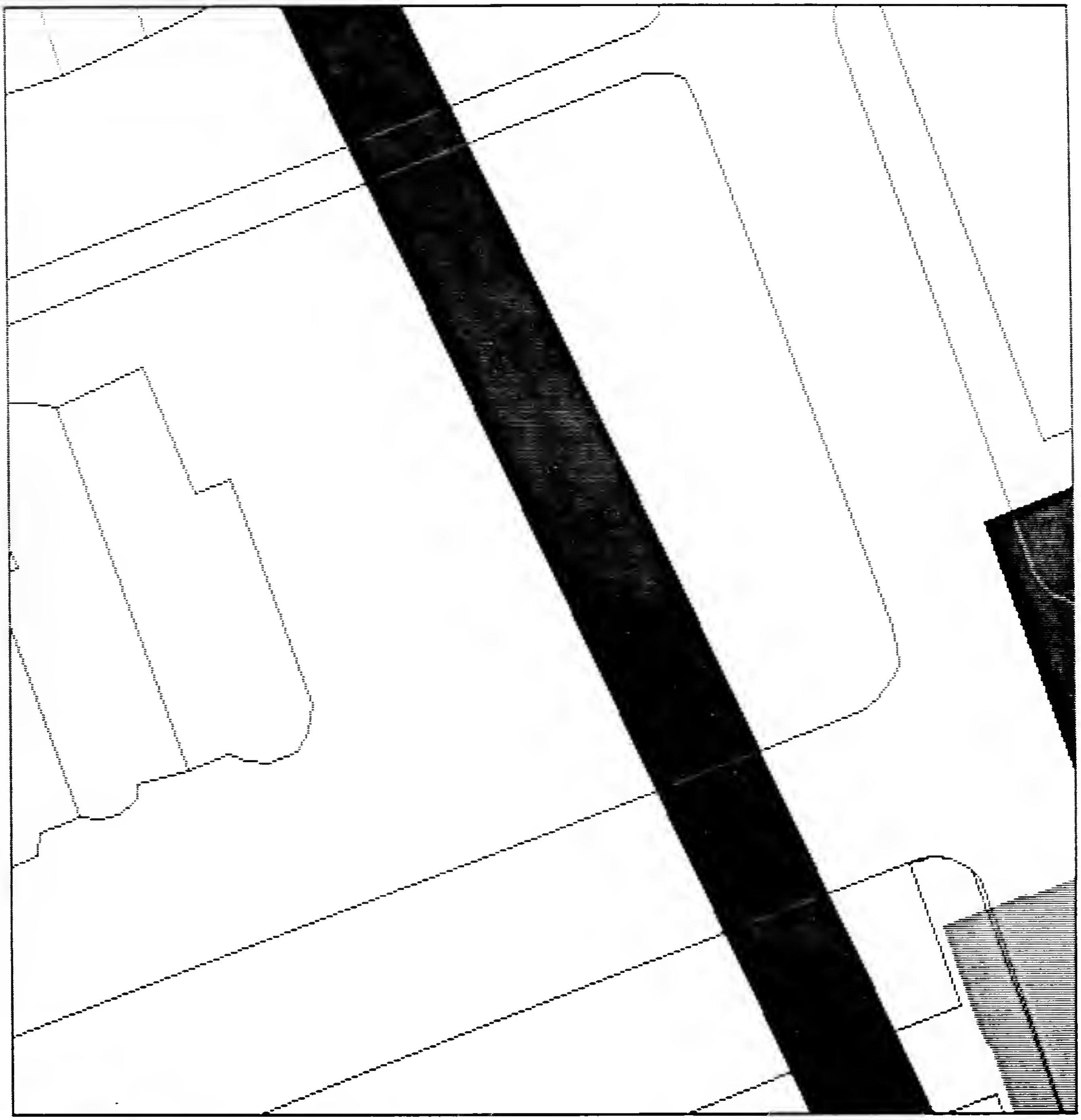
Existing shadow

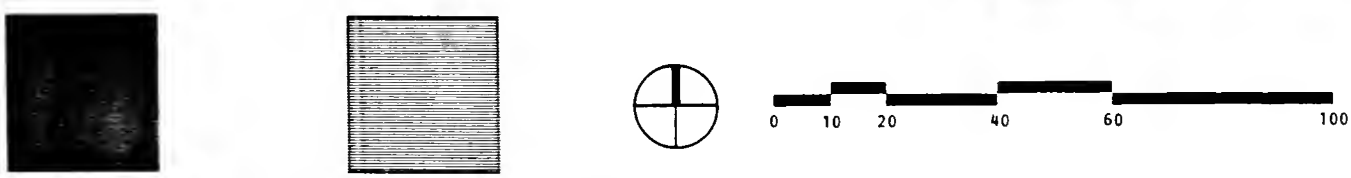
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

28 December 10:00am





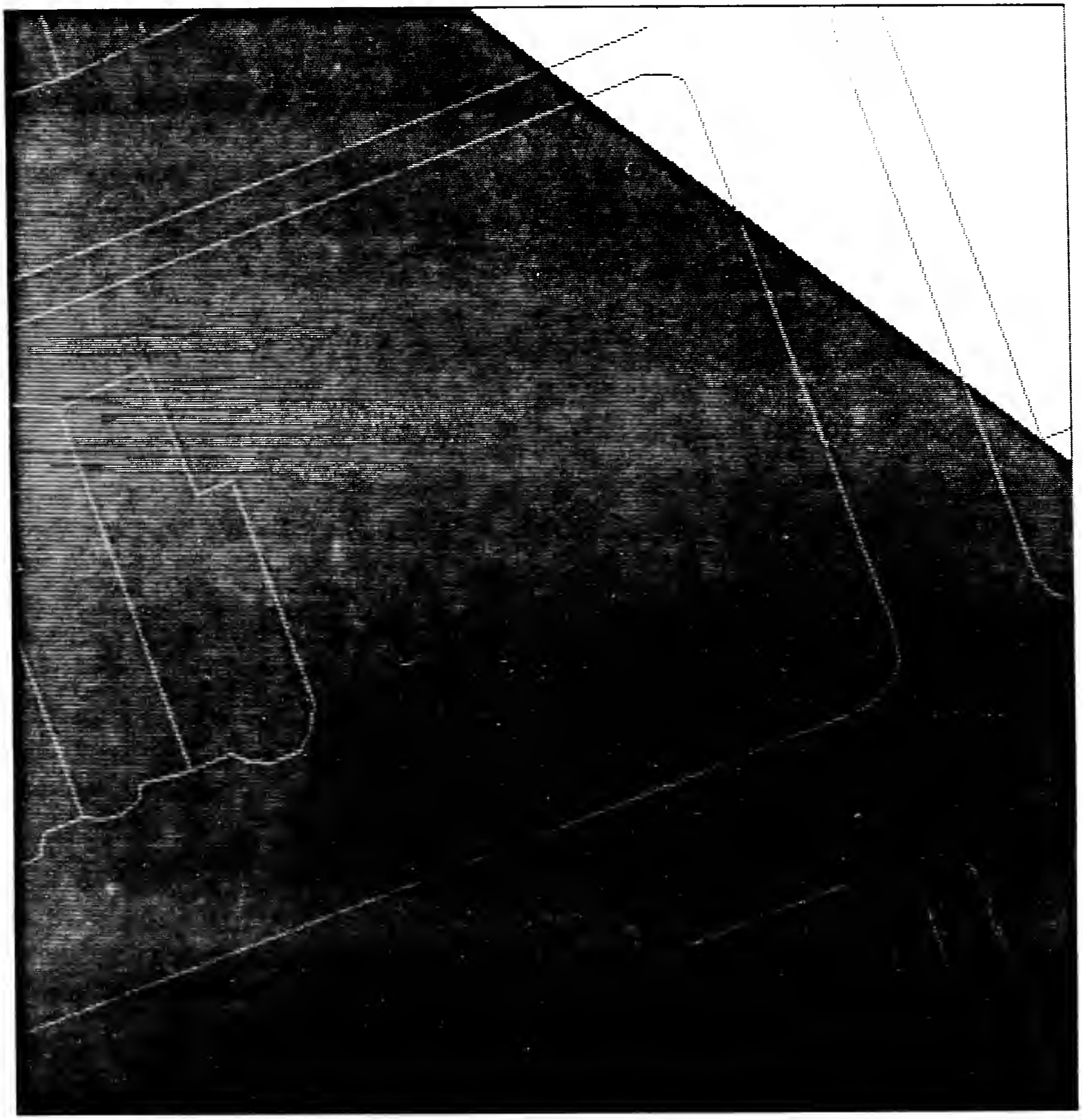
Existing shadow

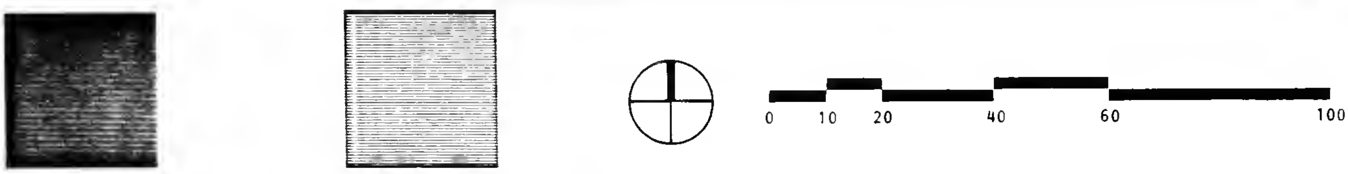
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

4 January 7:45am





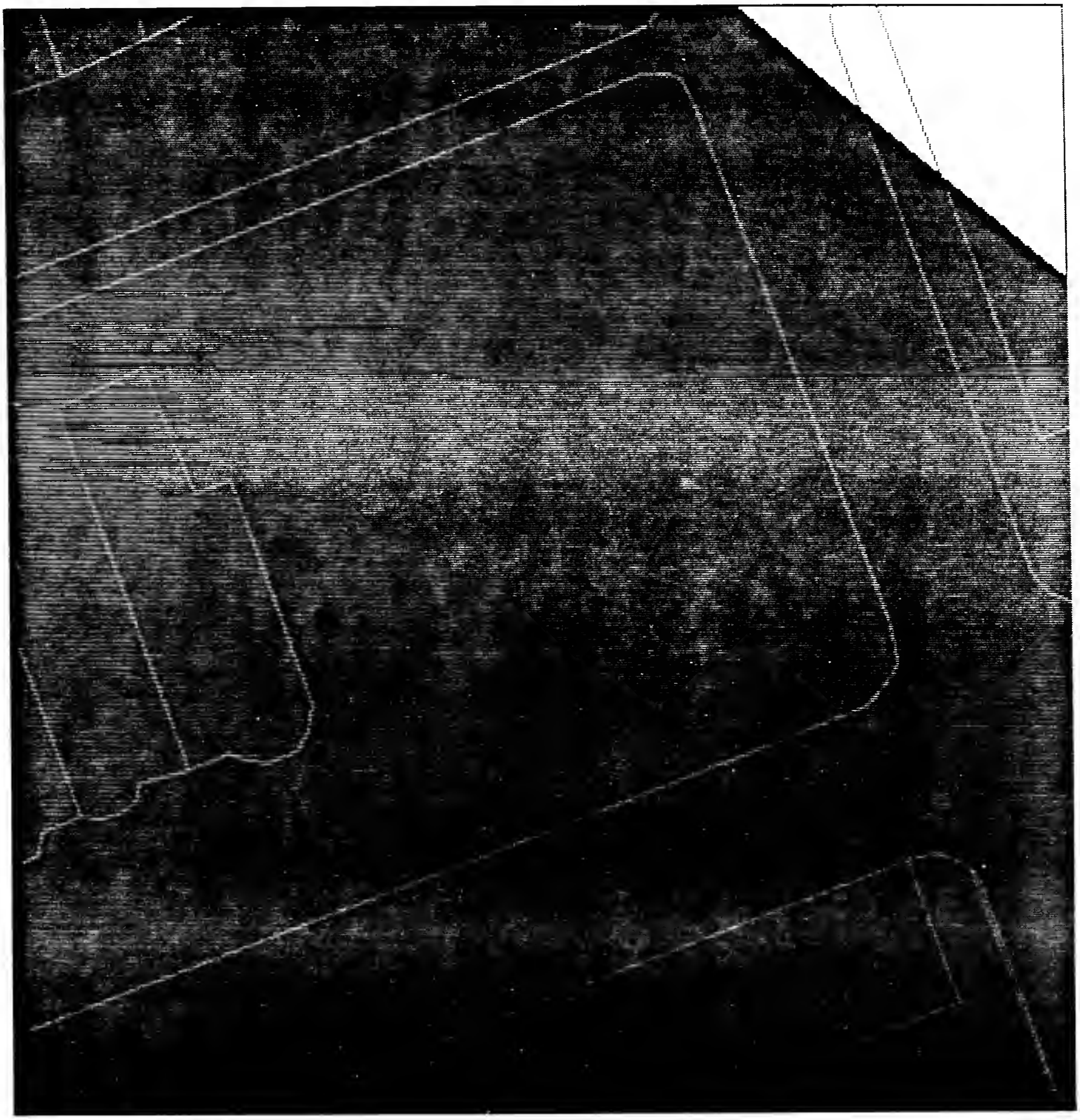
Existing shadow

Incremental shadow
New England Life Project

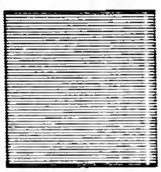
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

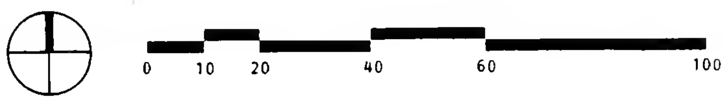
4 January 8:00am



Existing shadow



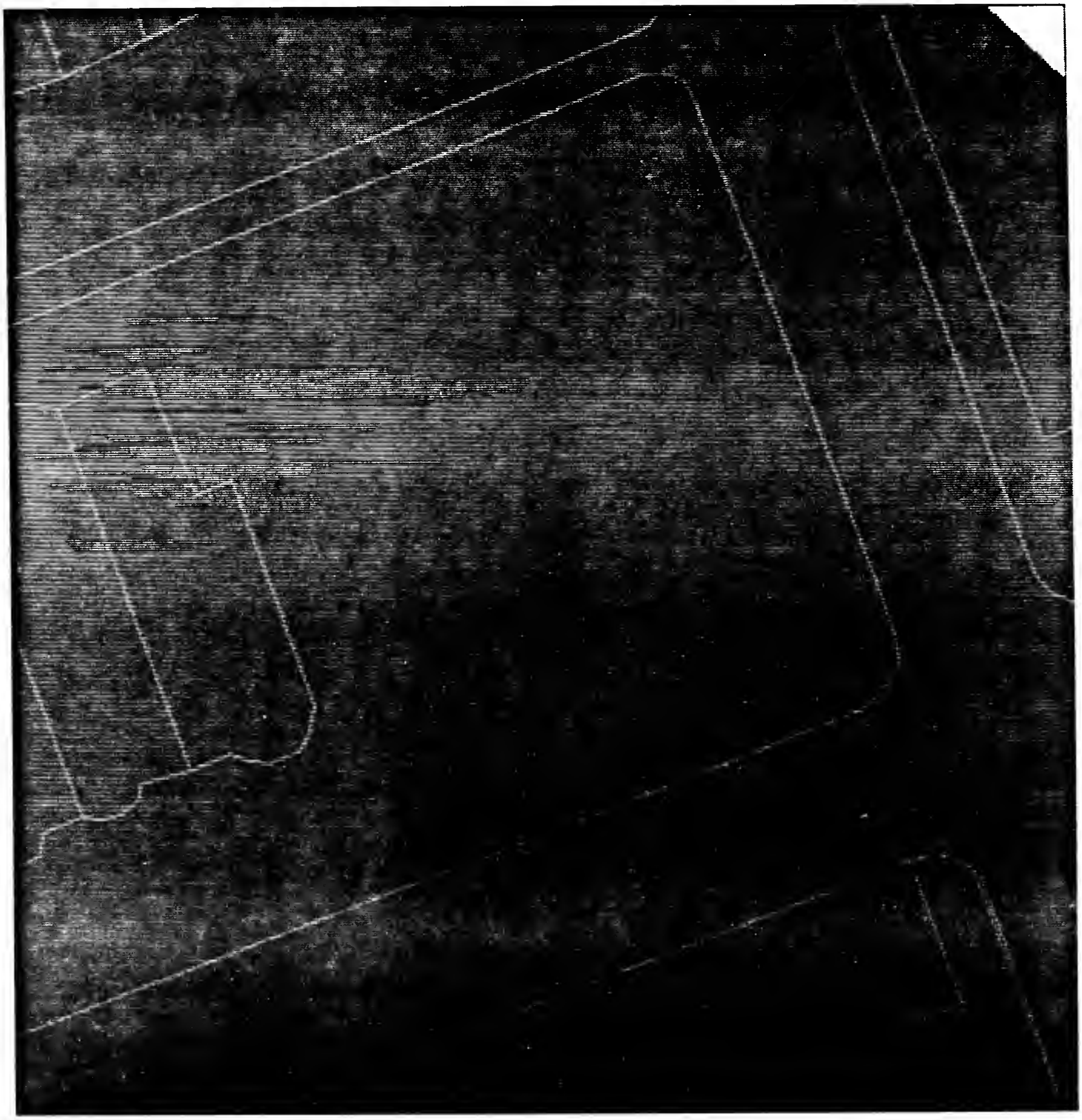
Incremental shadow
New England Life Project

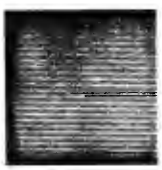


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

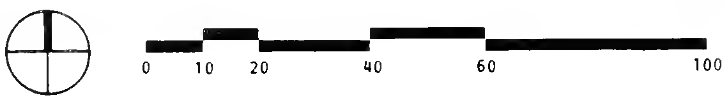
4 January 8:15am





Existing shadow

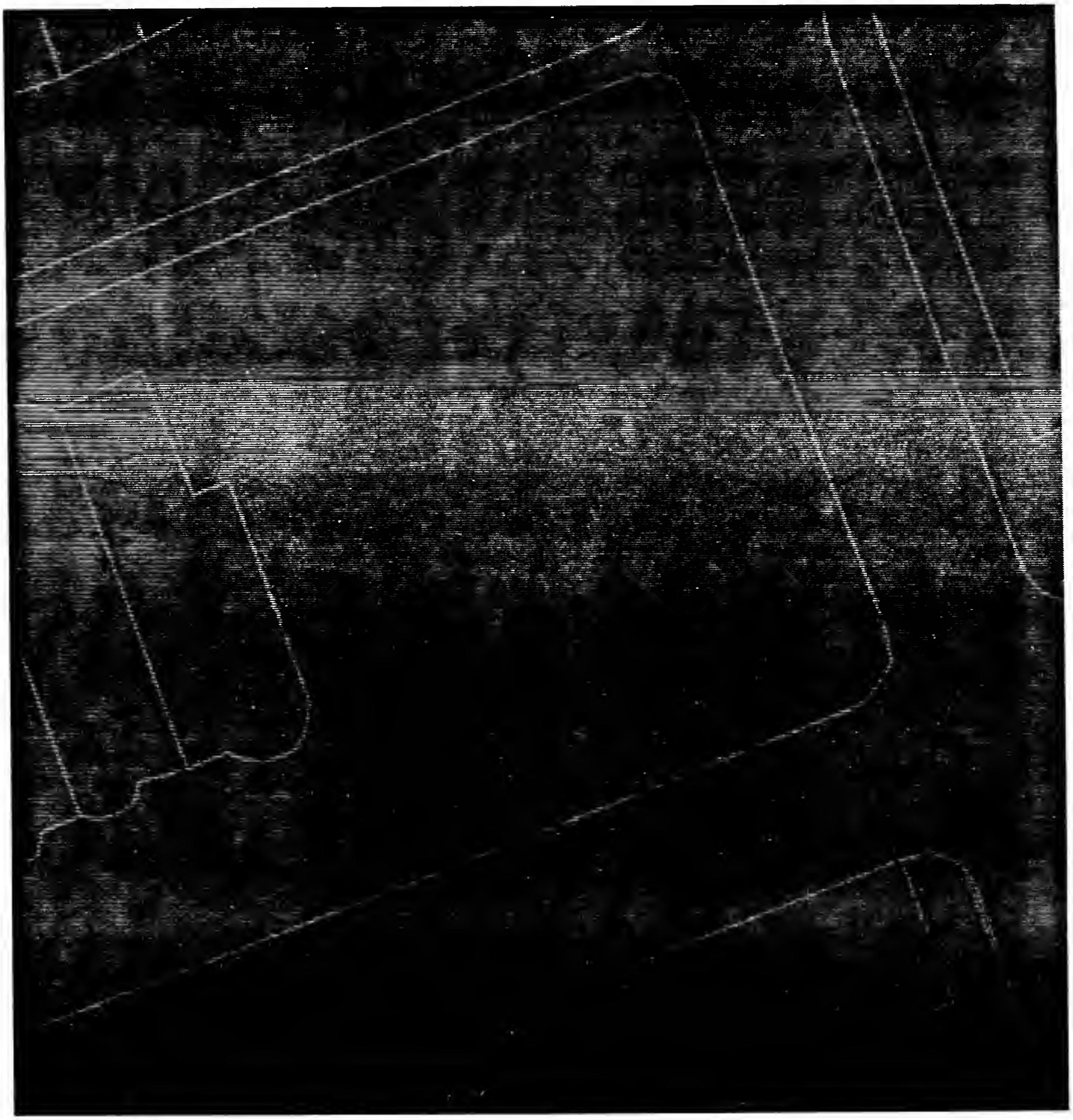
Incremental shadow
New England Life Project

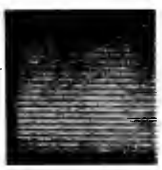


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

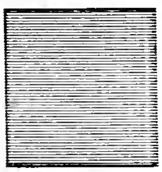
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

4 January 8:30am

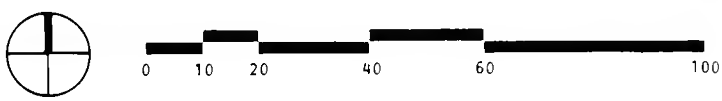




Existing shadow



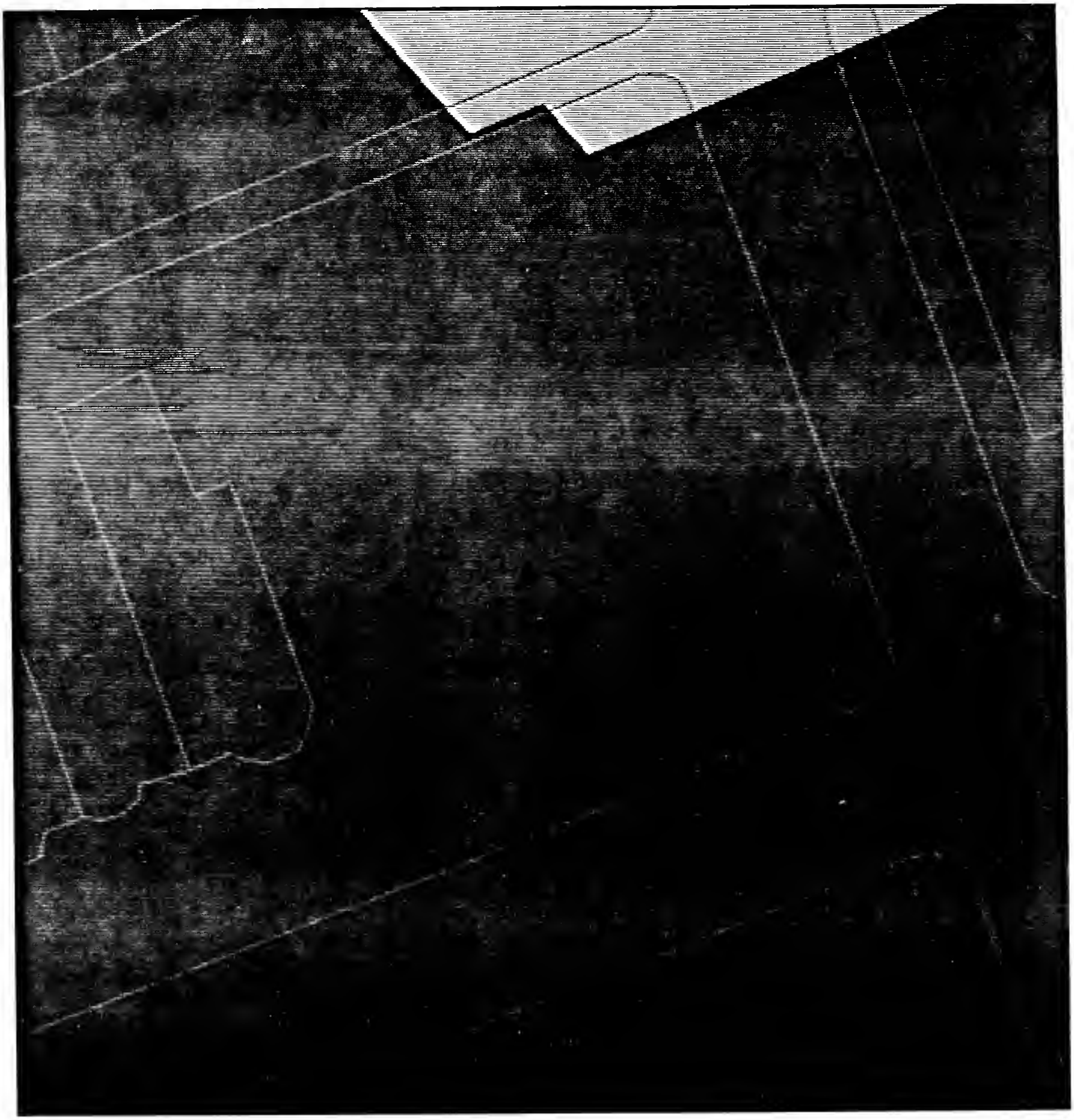
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

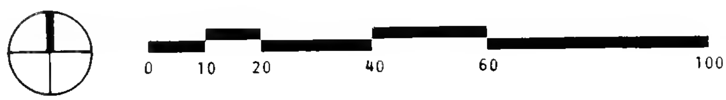
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

4 January 8:45am



Existing shadow

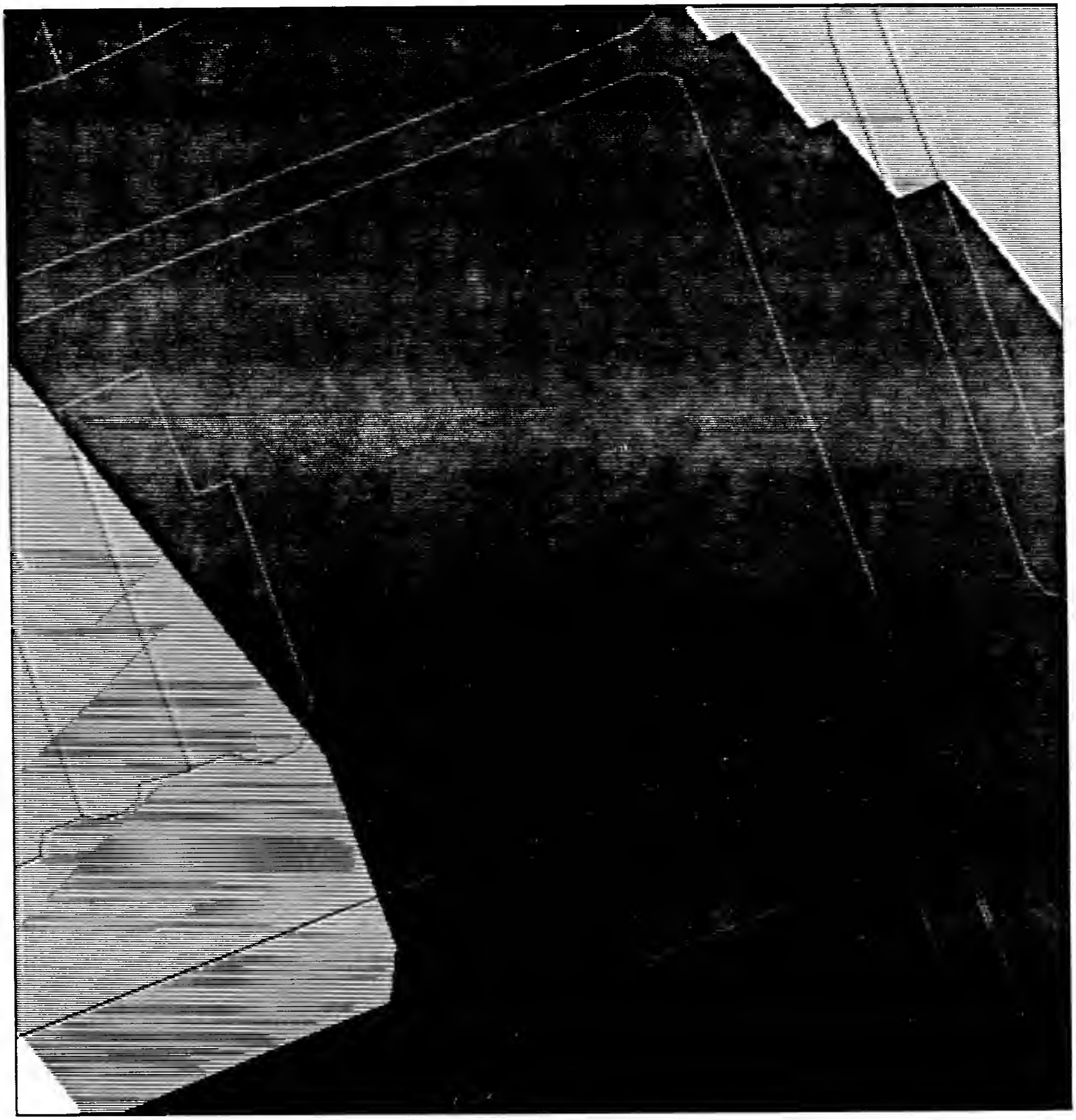
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

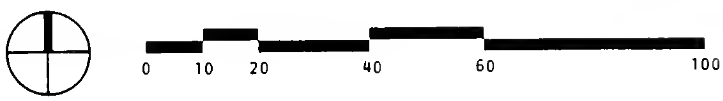
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

4 January 9:00am



Existing shadow

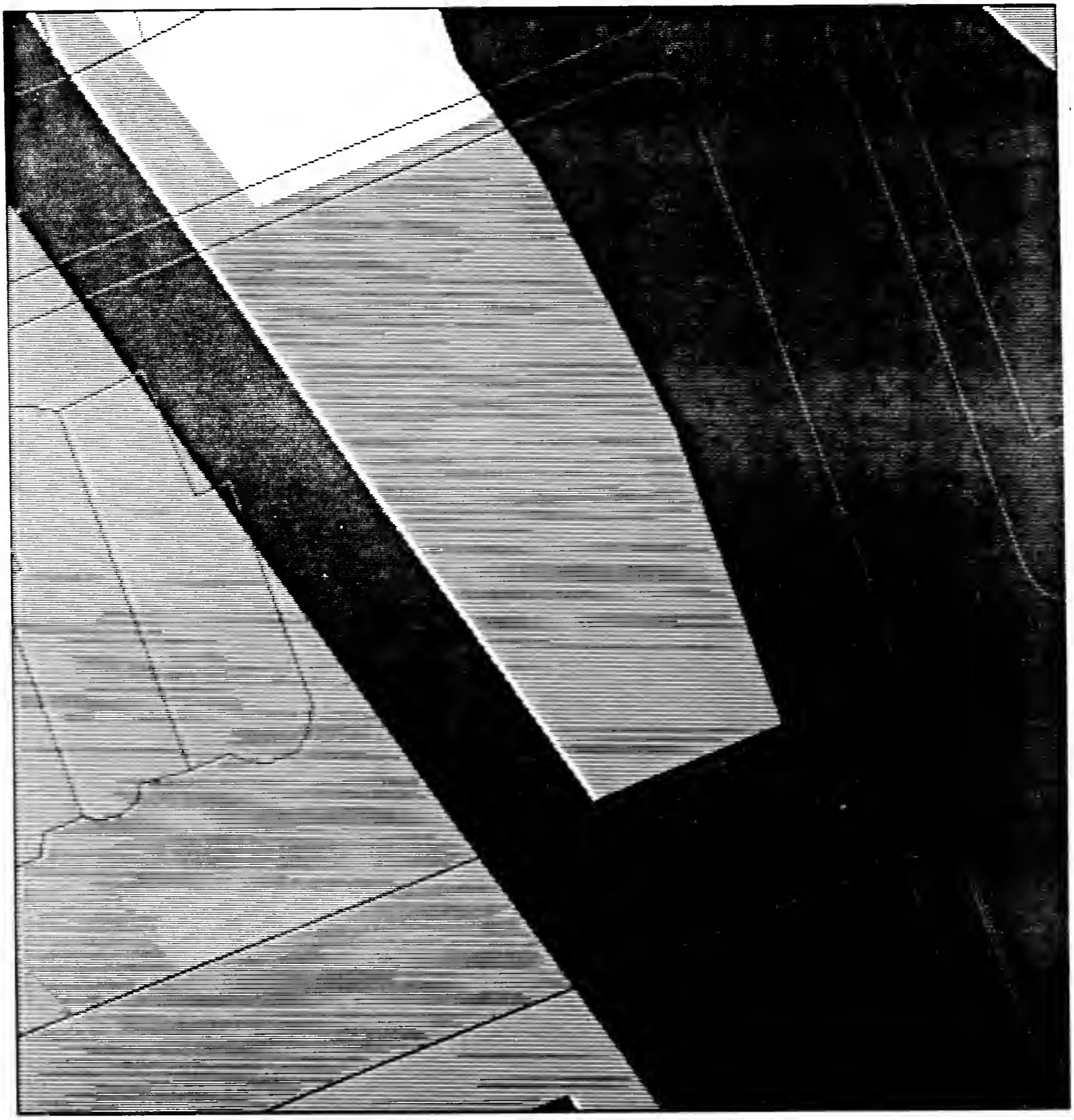
Incremental shadow
New England Life Project

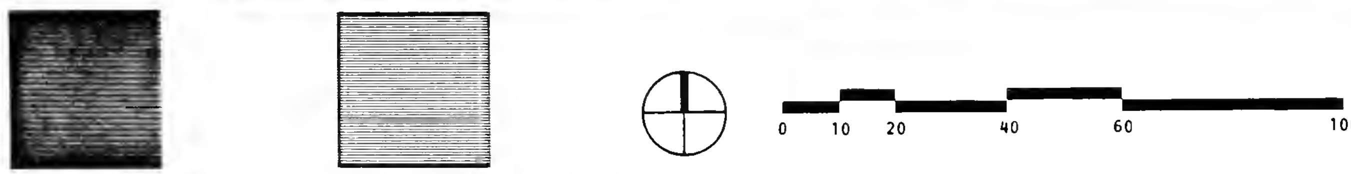


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

4 January 9:15am





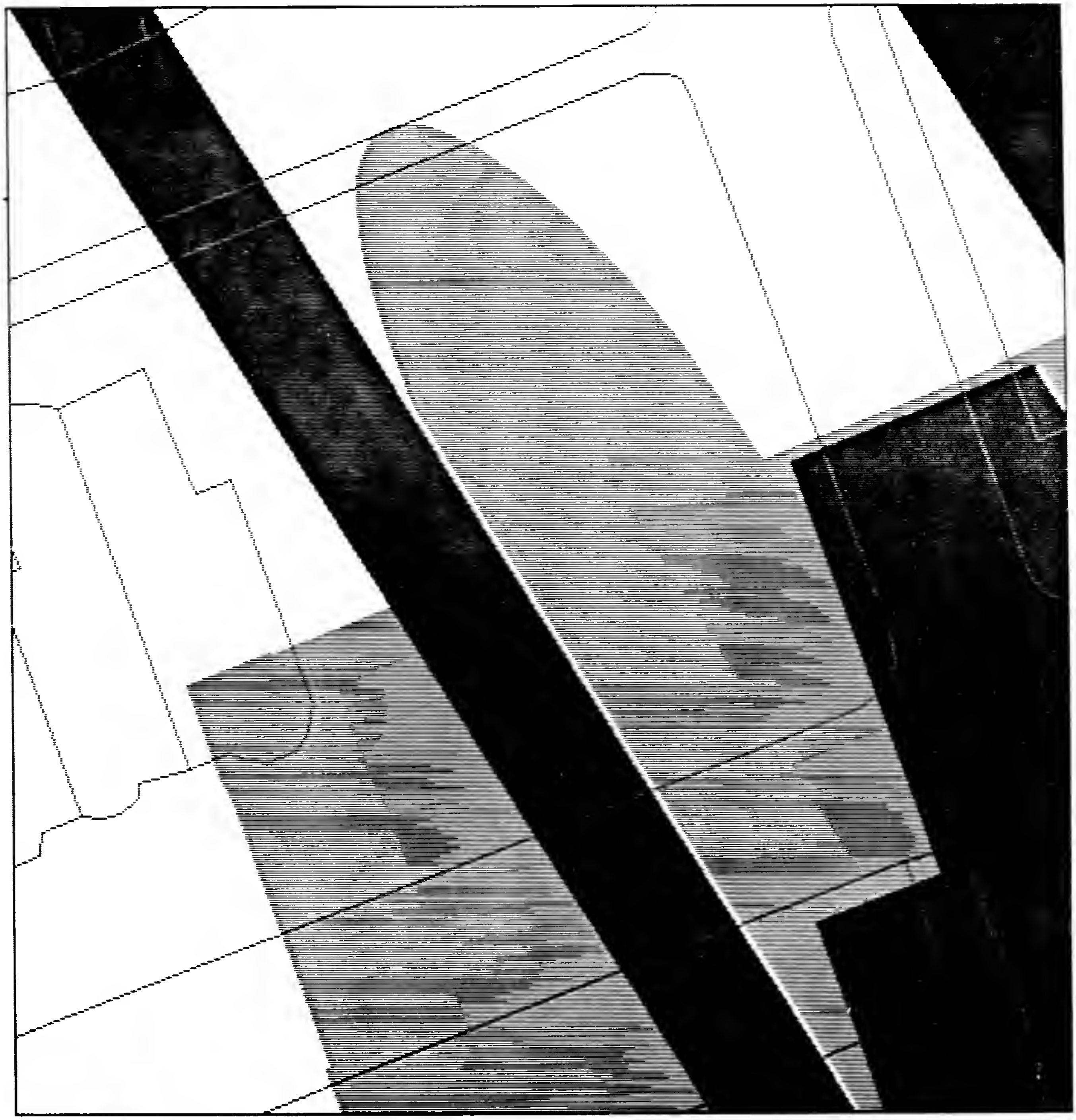
Existing shadow

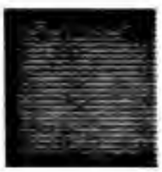
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

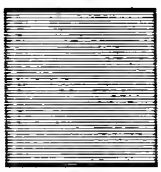
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

4 January 9:30am

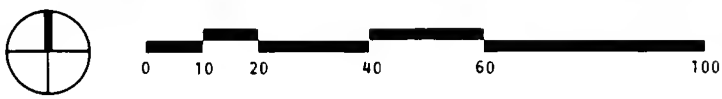




Existing shadow



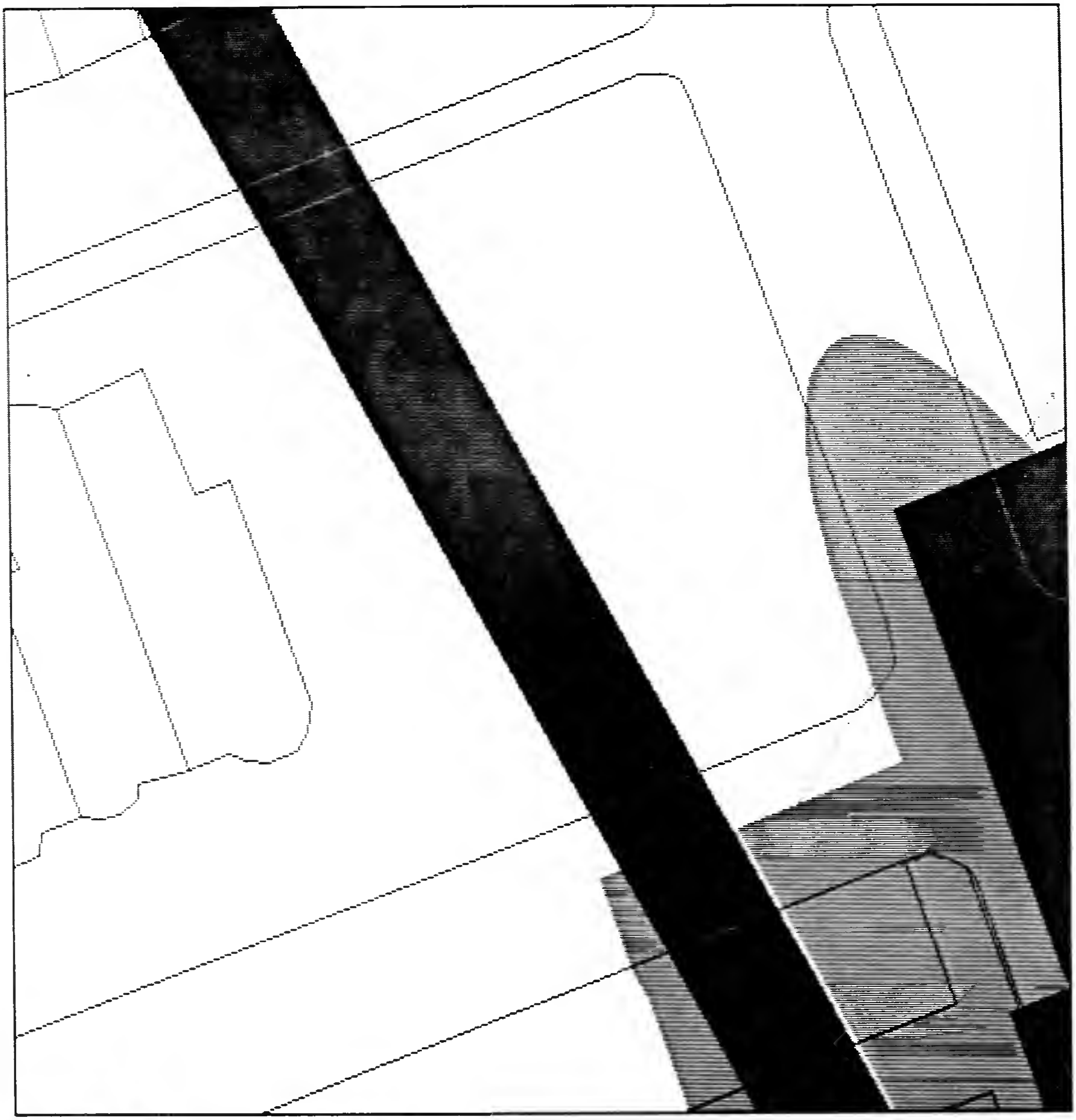
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

4 January 9:45am



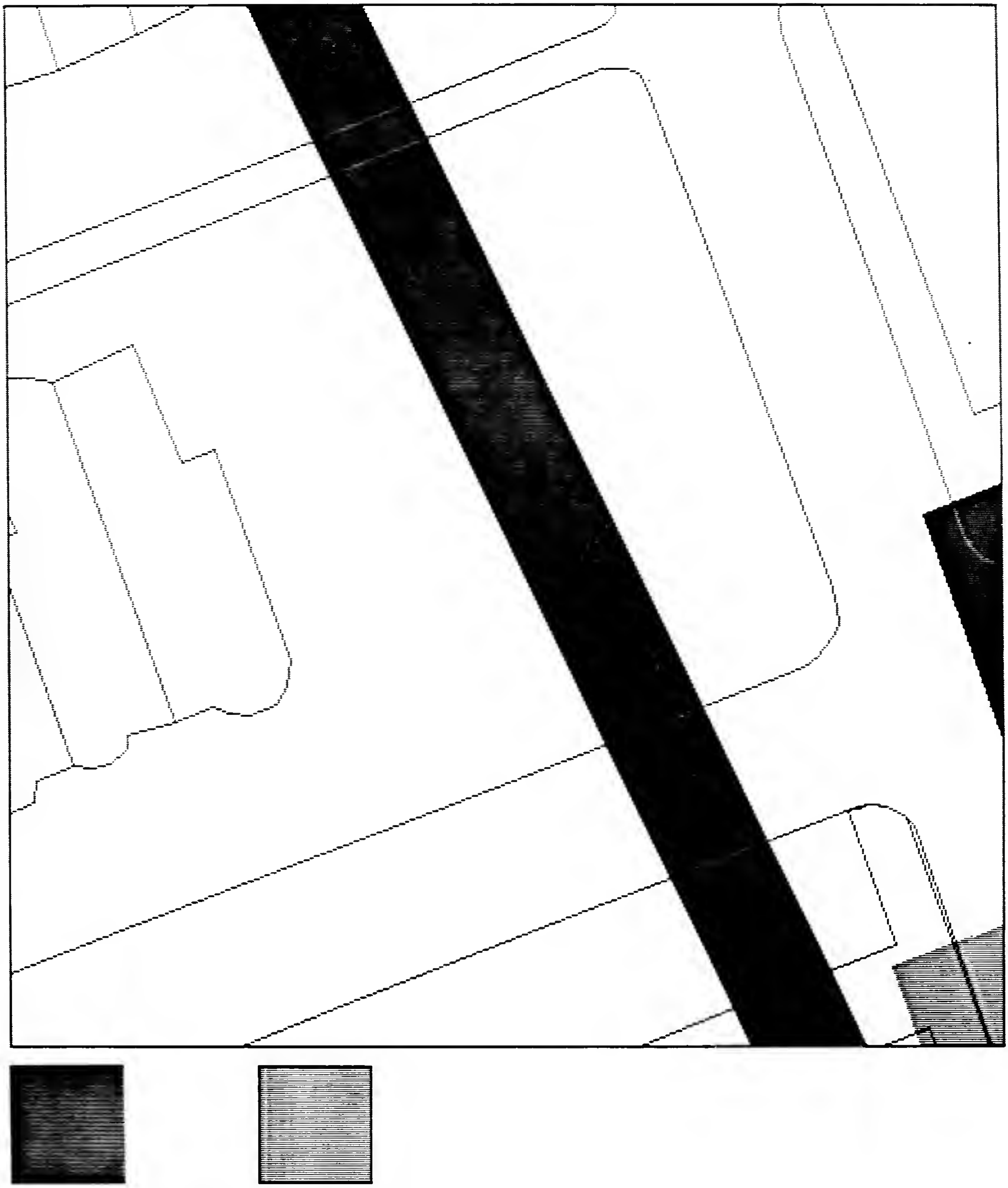
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

4 January 10:00am



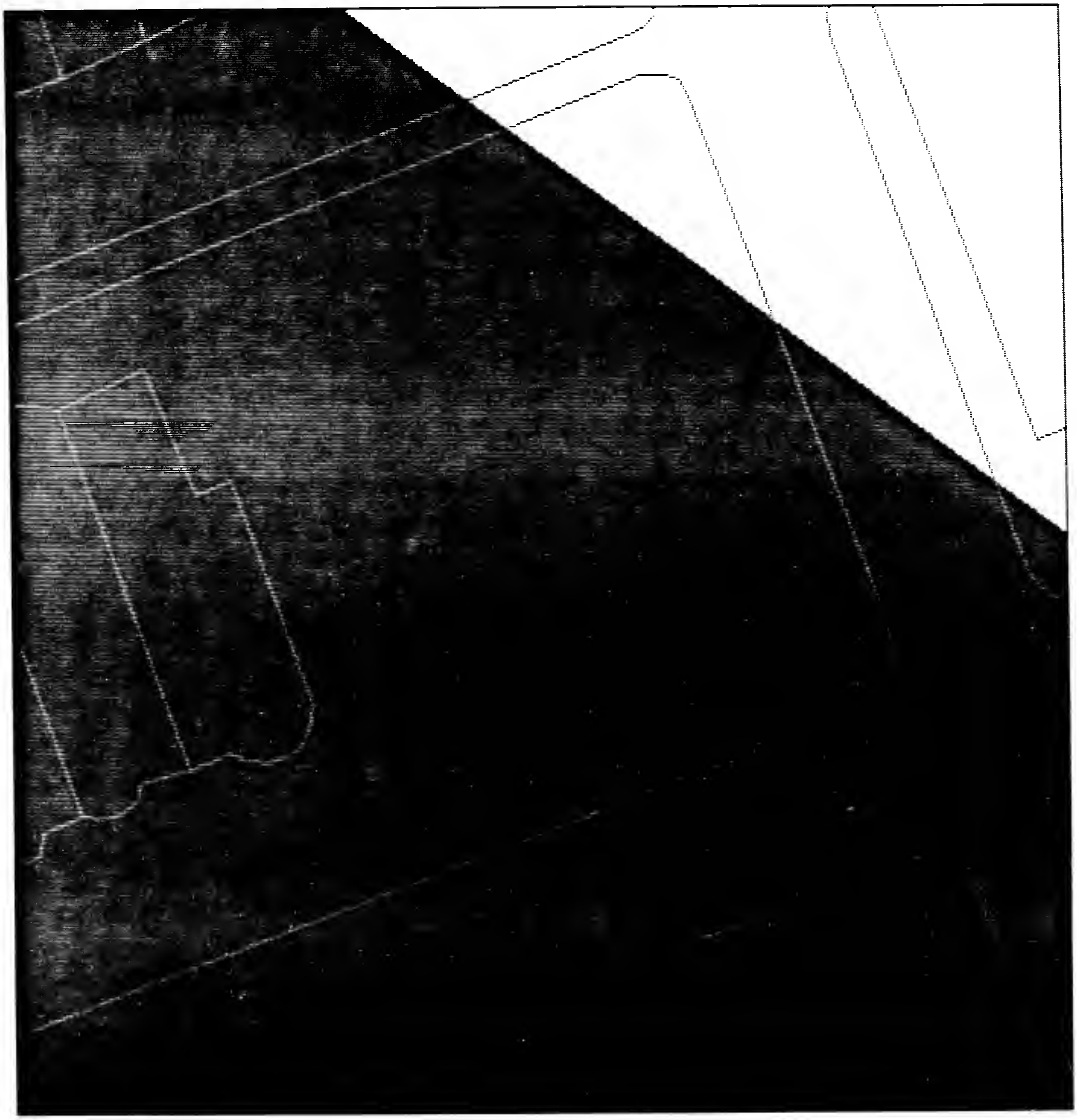
Existing shadow

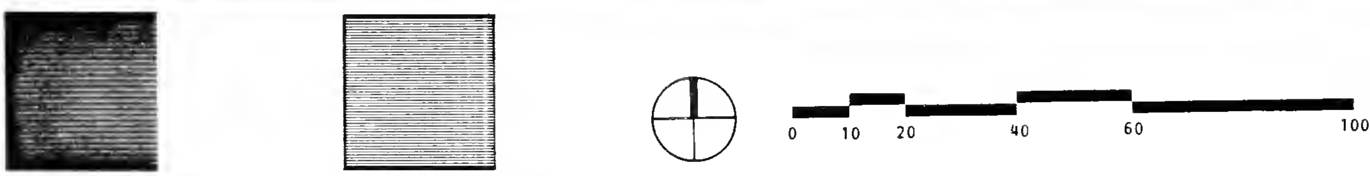
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

11 January 7:45am





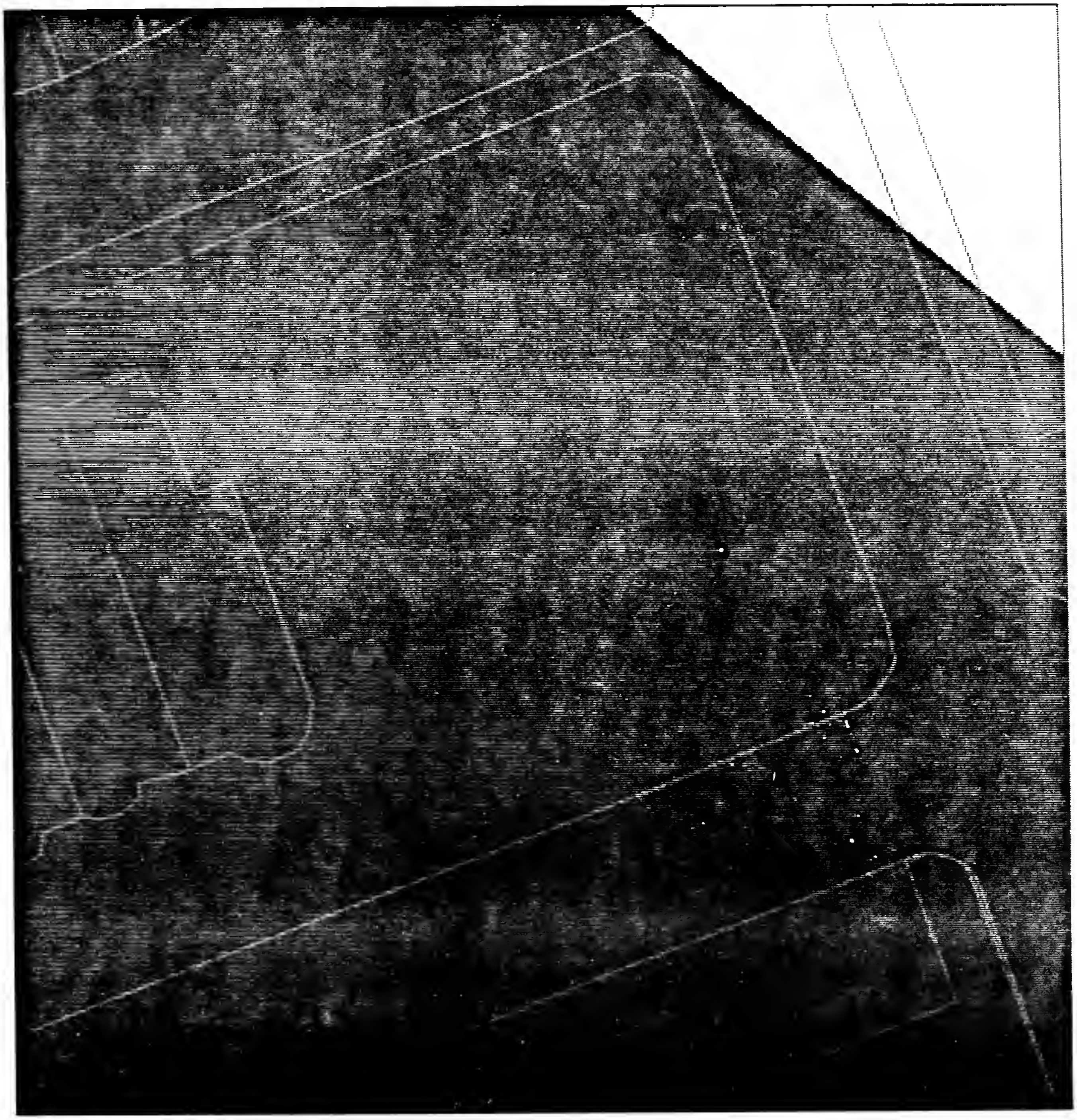
Existing shadow

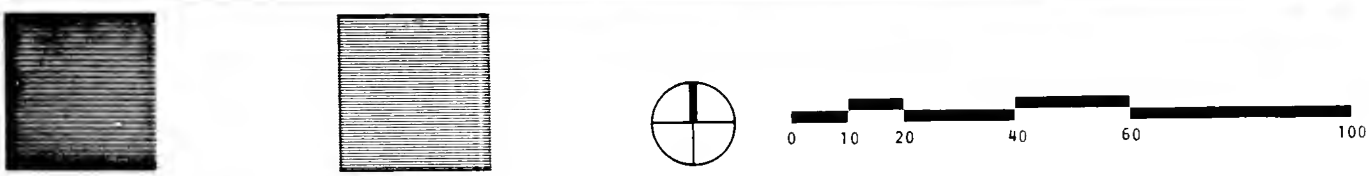
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

11 January 8:00am





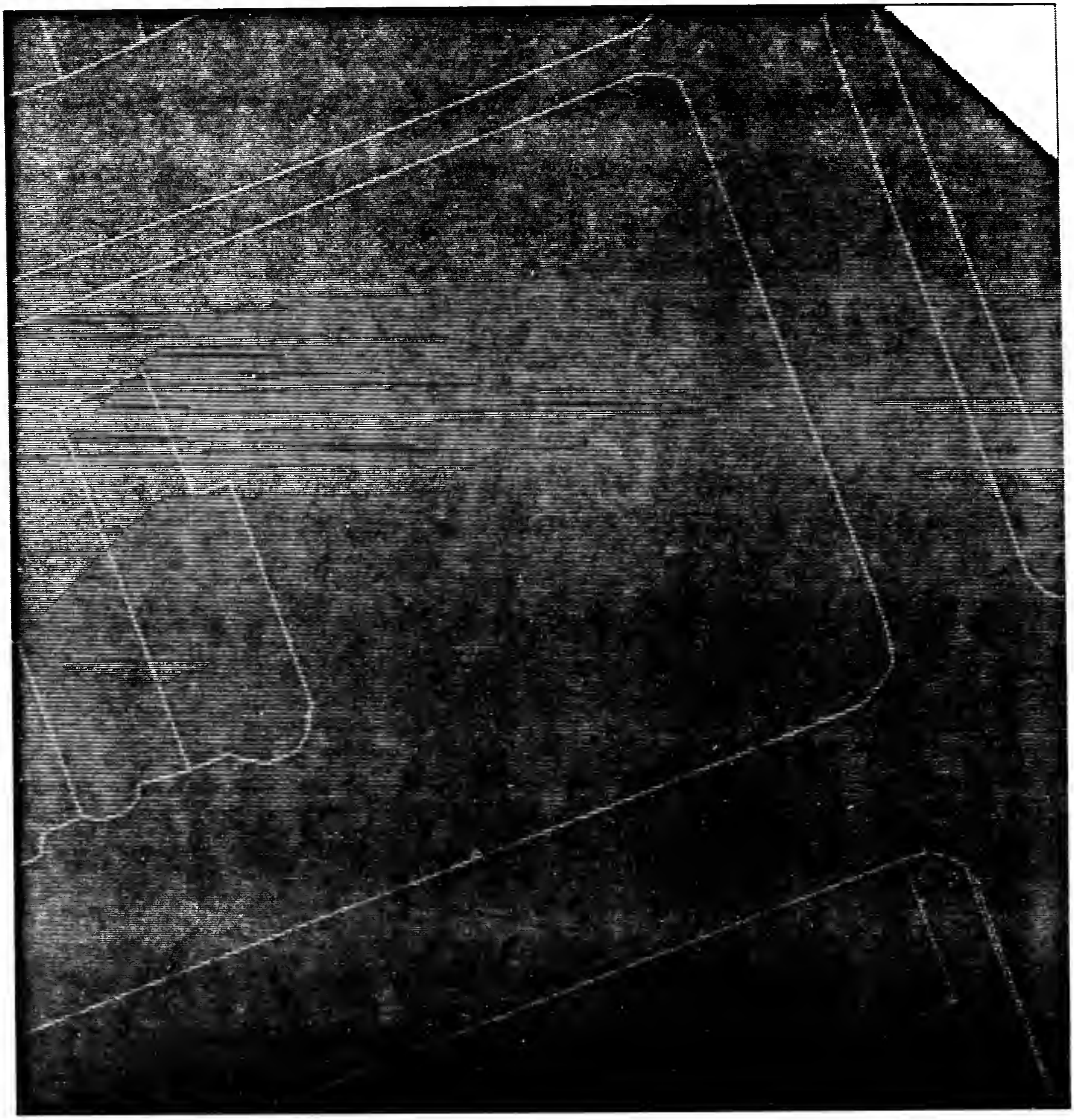
Existing shadow

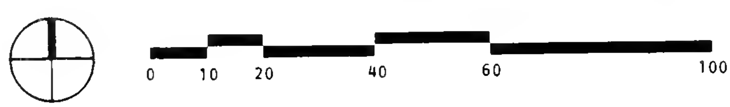
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

11 January 8:15am





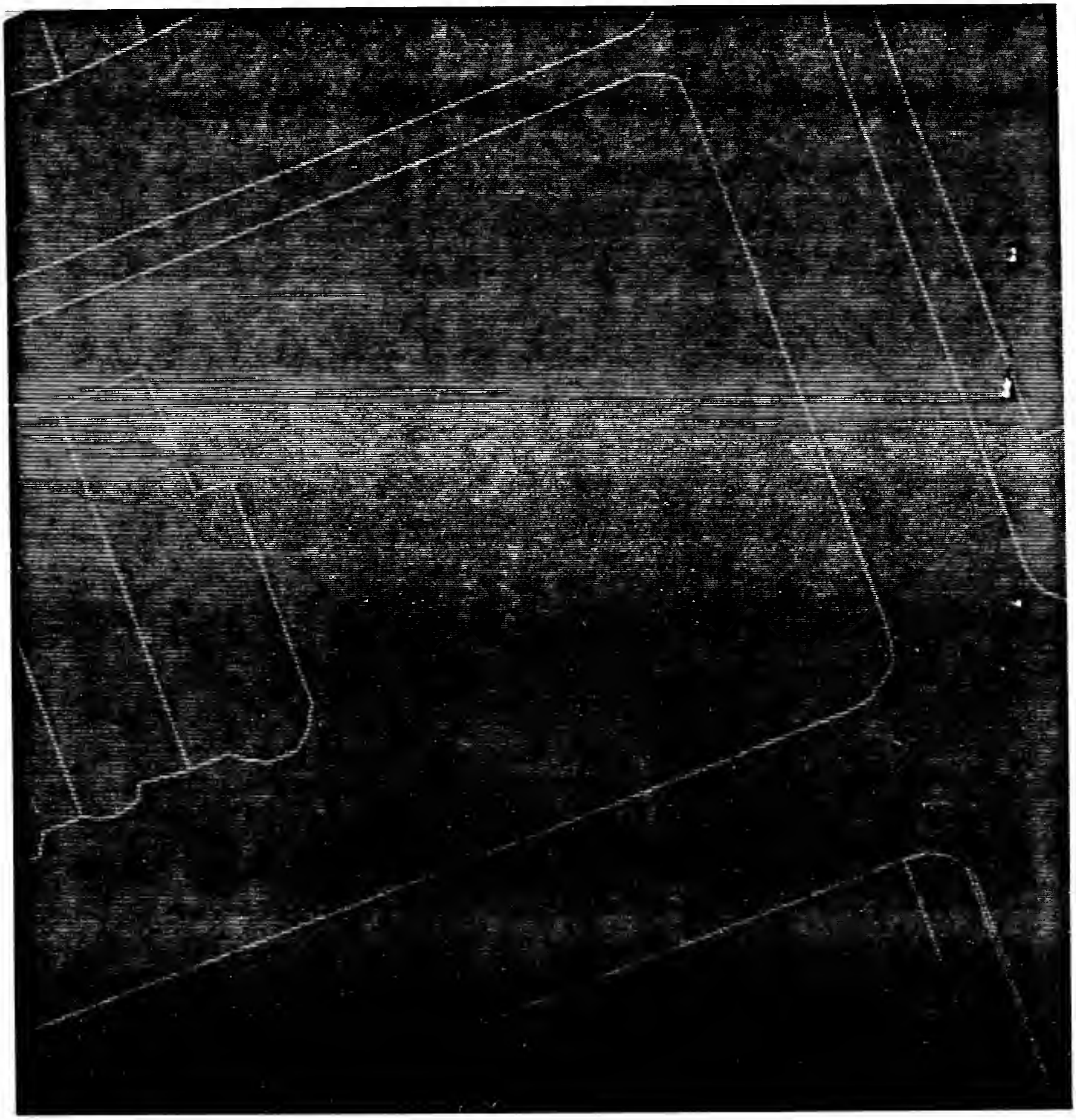
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

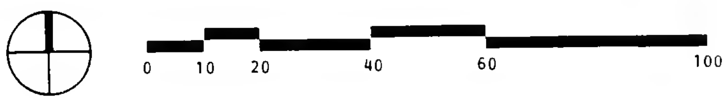
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

11 January 8:30am



Existing shadow

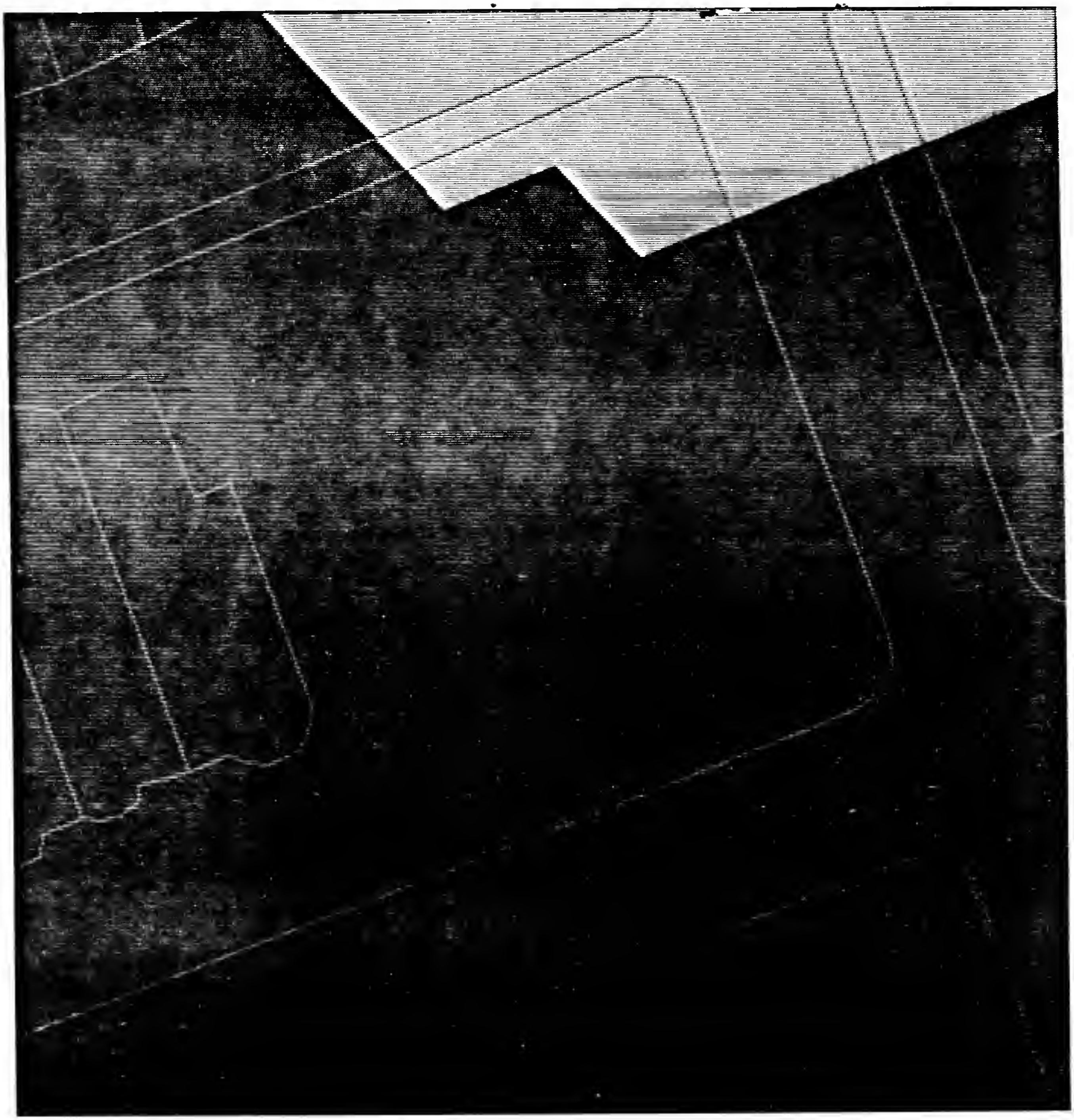
Incremental shadow
New England Life Project

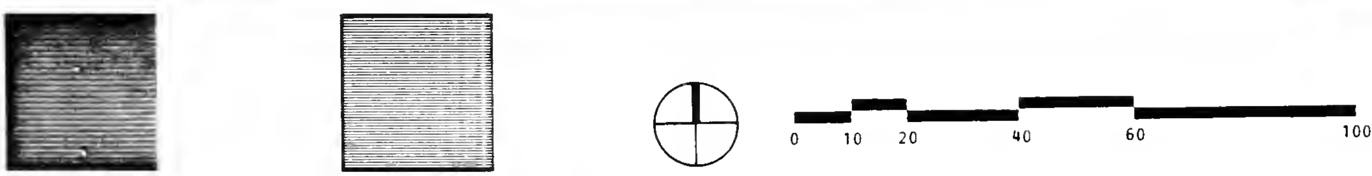


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

11 January 8:45am





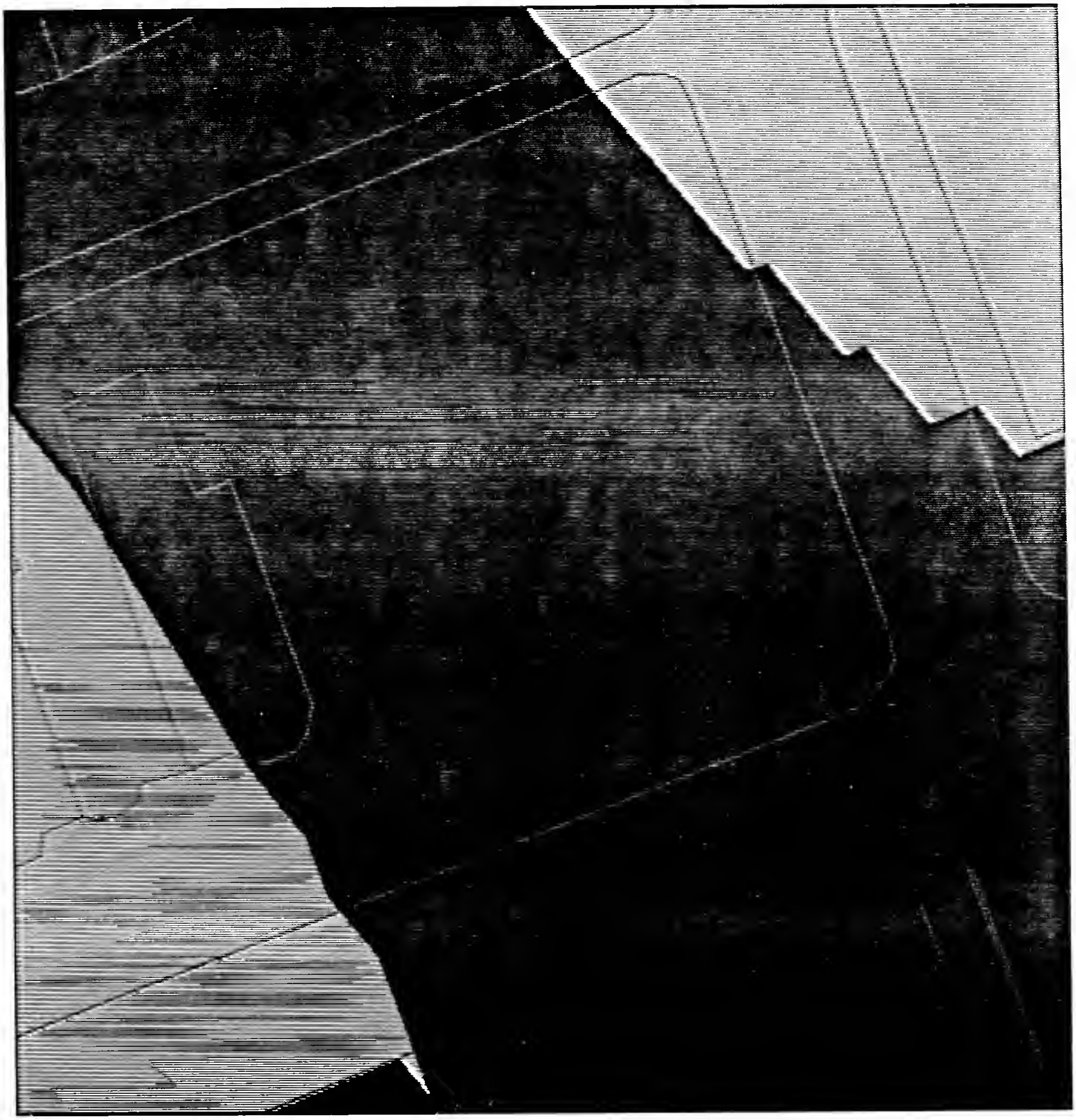
Existing shadow

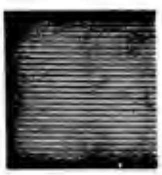
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

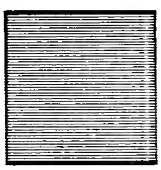
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

11 January 9:00am

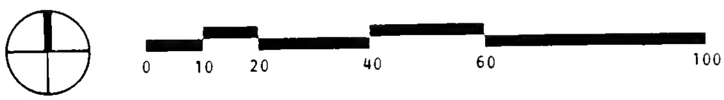




Existing shadow



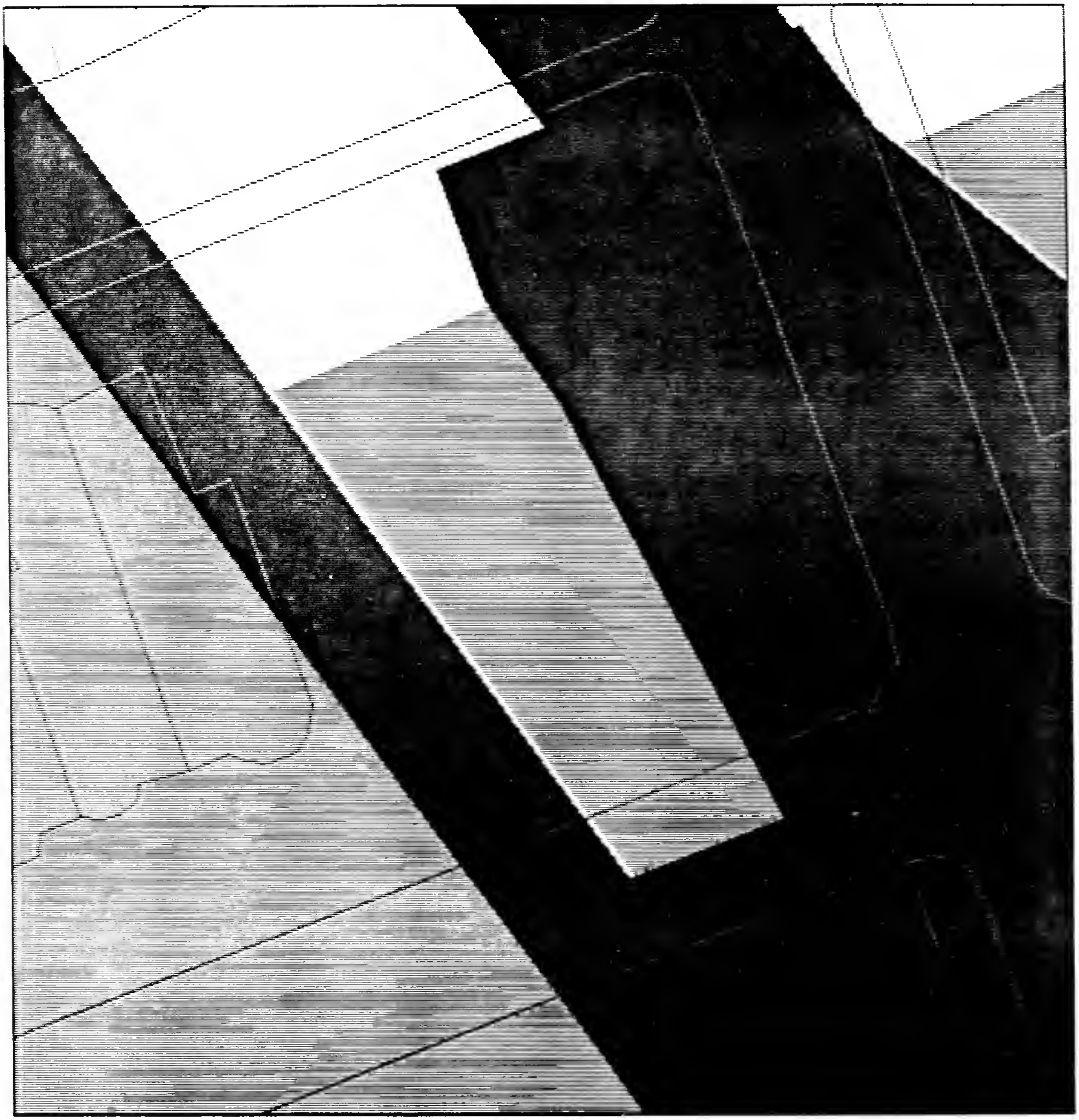
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

11 January 9:15am



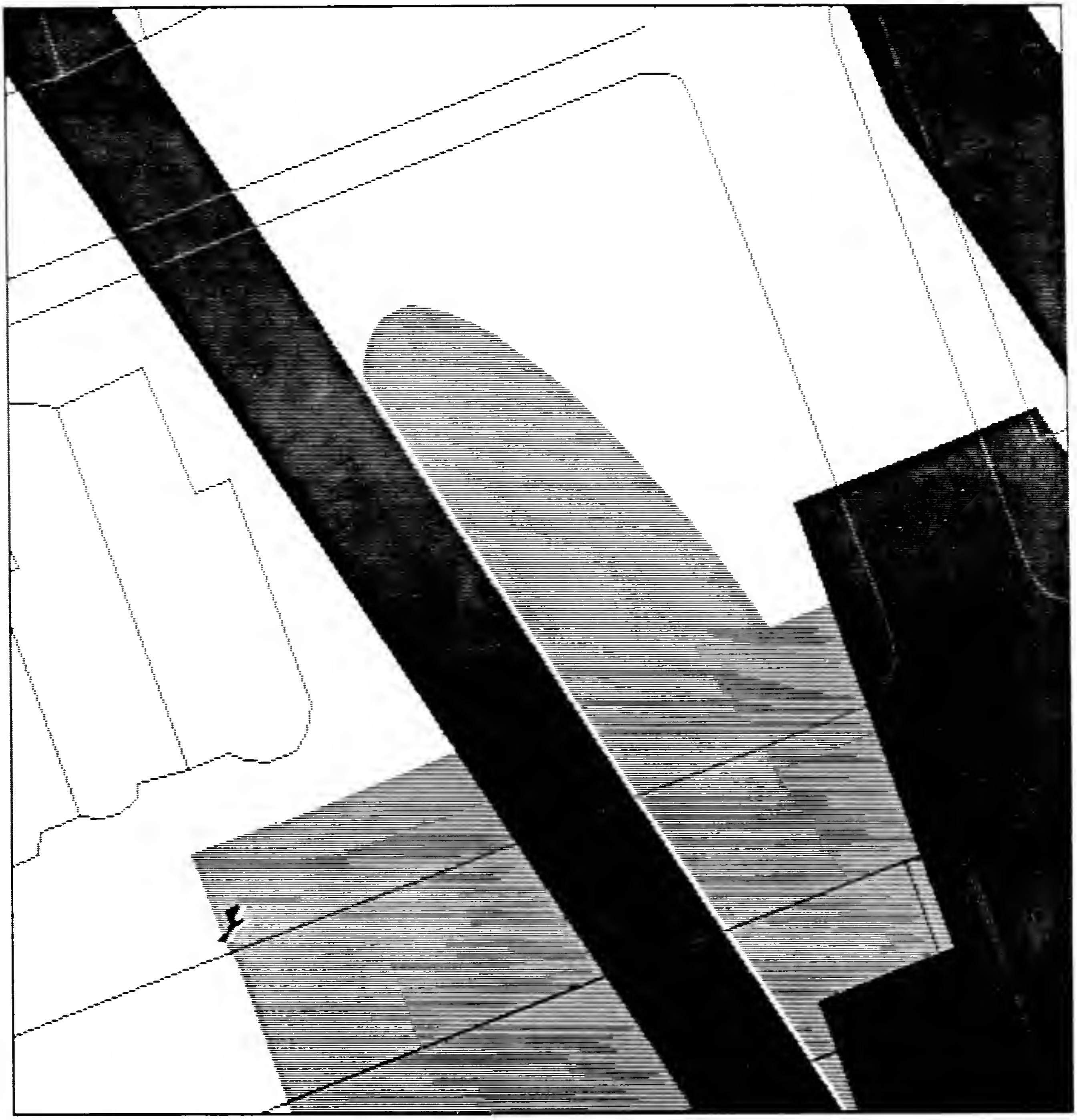
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

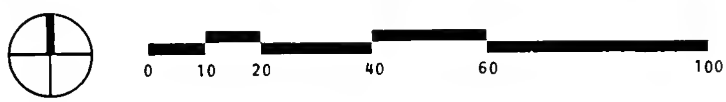
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

11 January 9:30am



Existing shadow

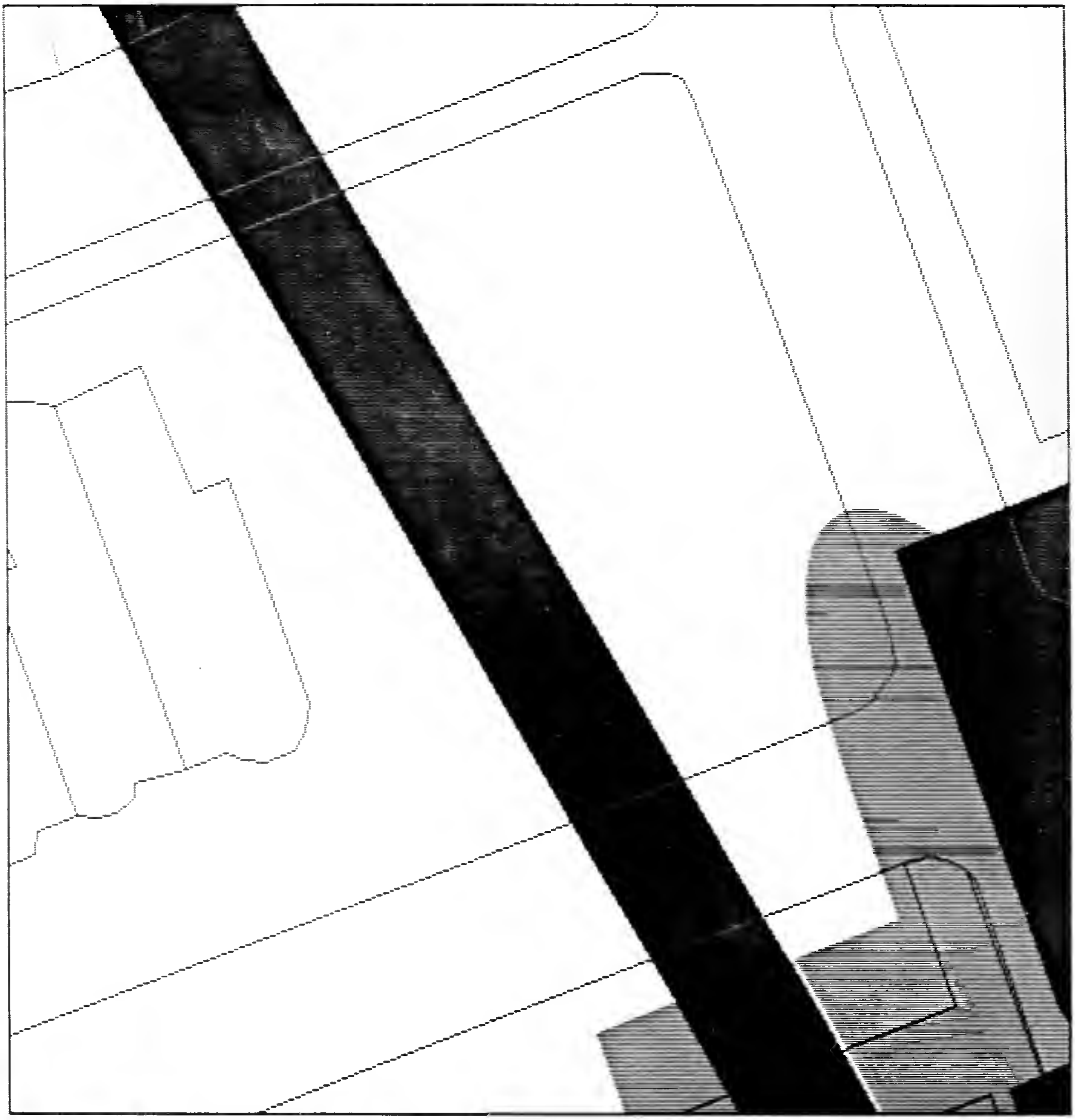
Incremental shadow
New England Life Project

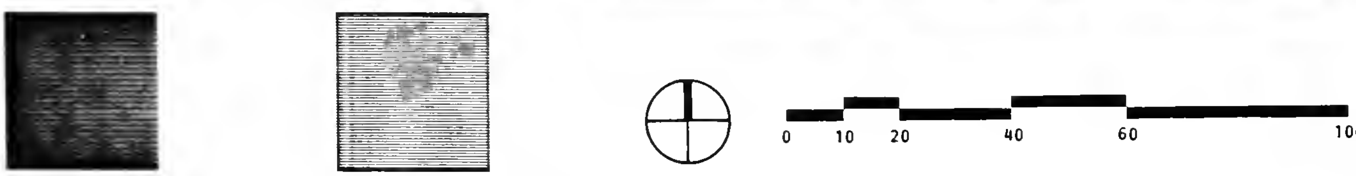


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

11 January 9:45am





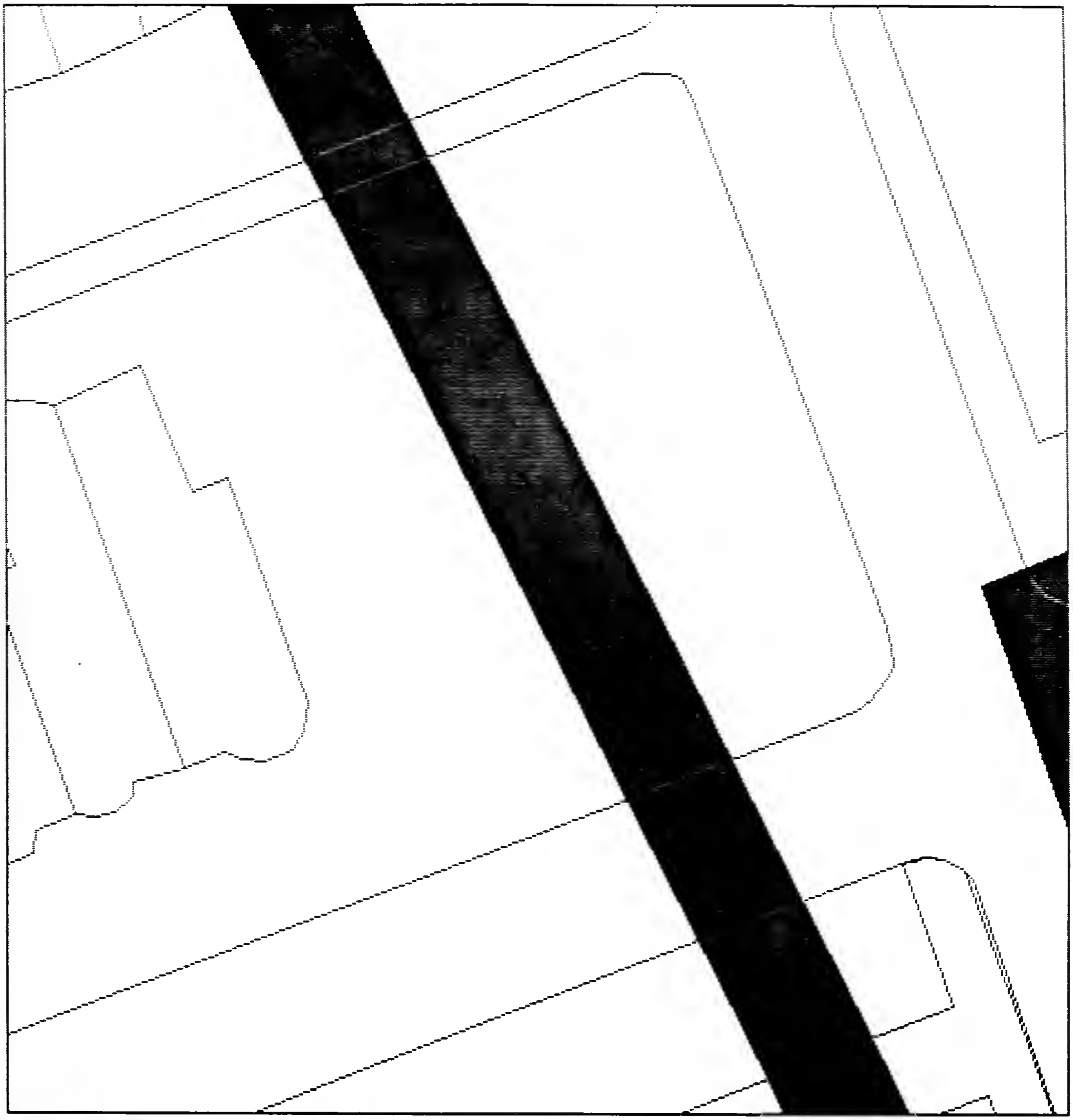
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

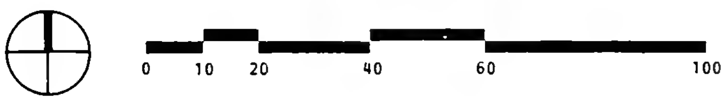
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

11 January 10:00am



Existing shadow

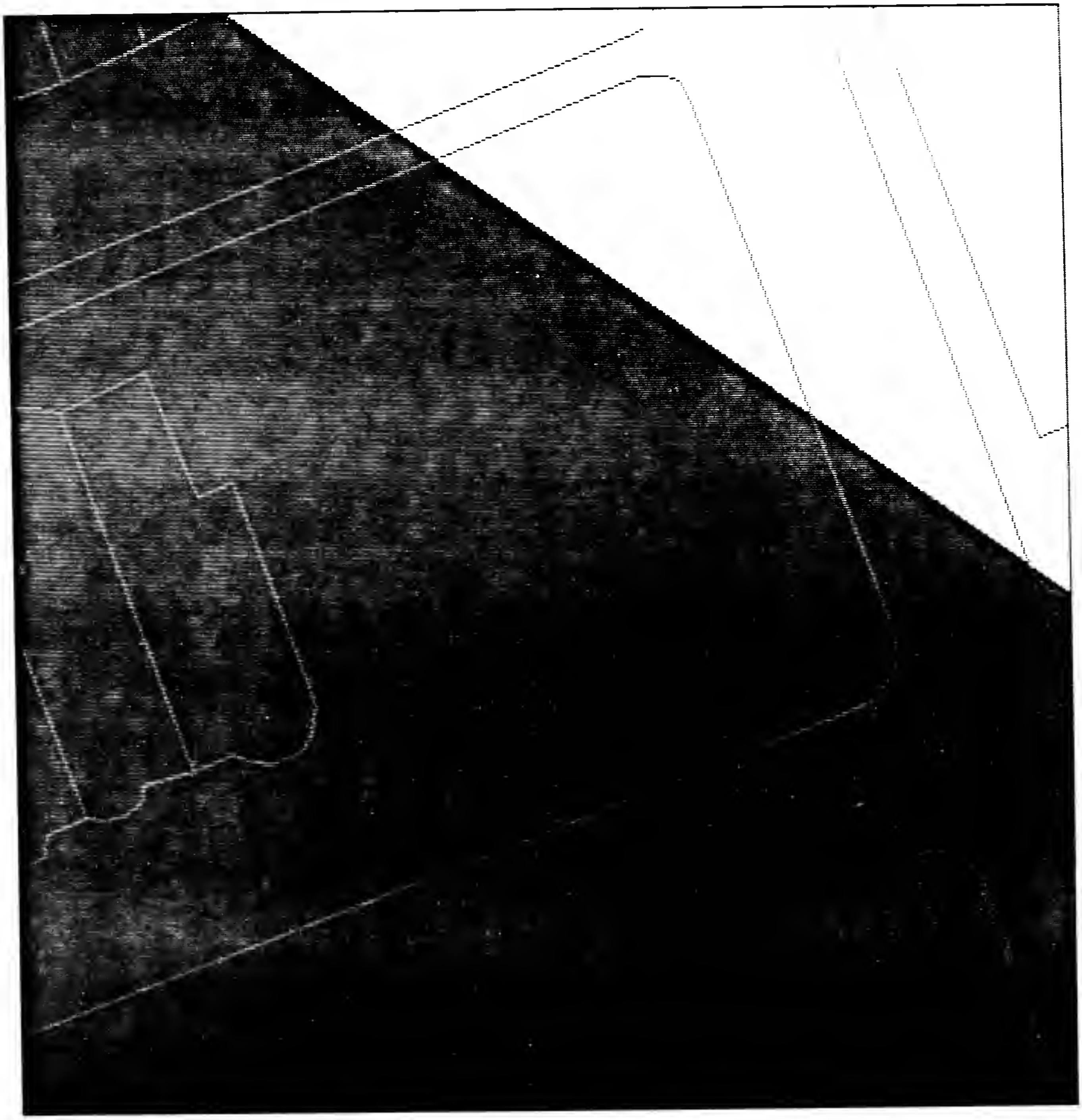
Incremental shadow
New England Life Project

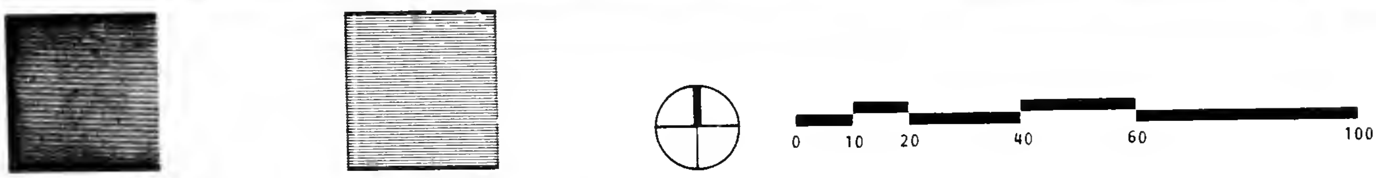


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

18 January 7:45am





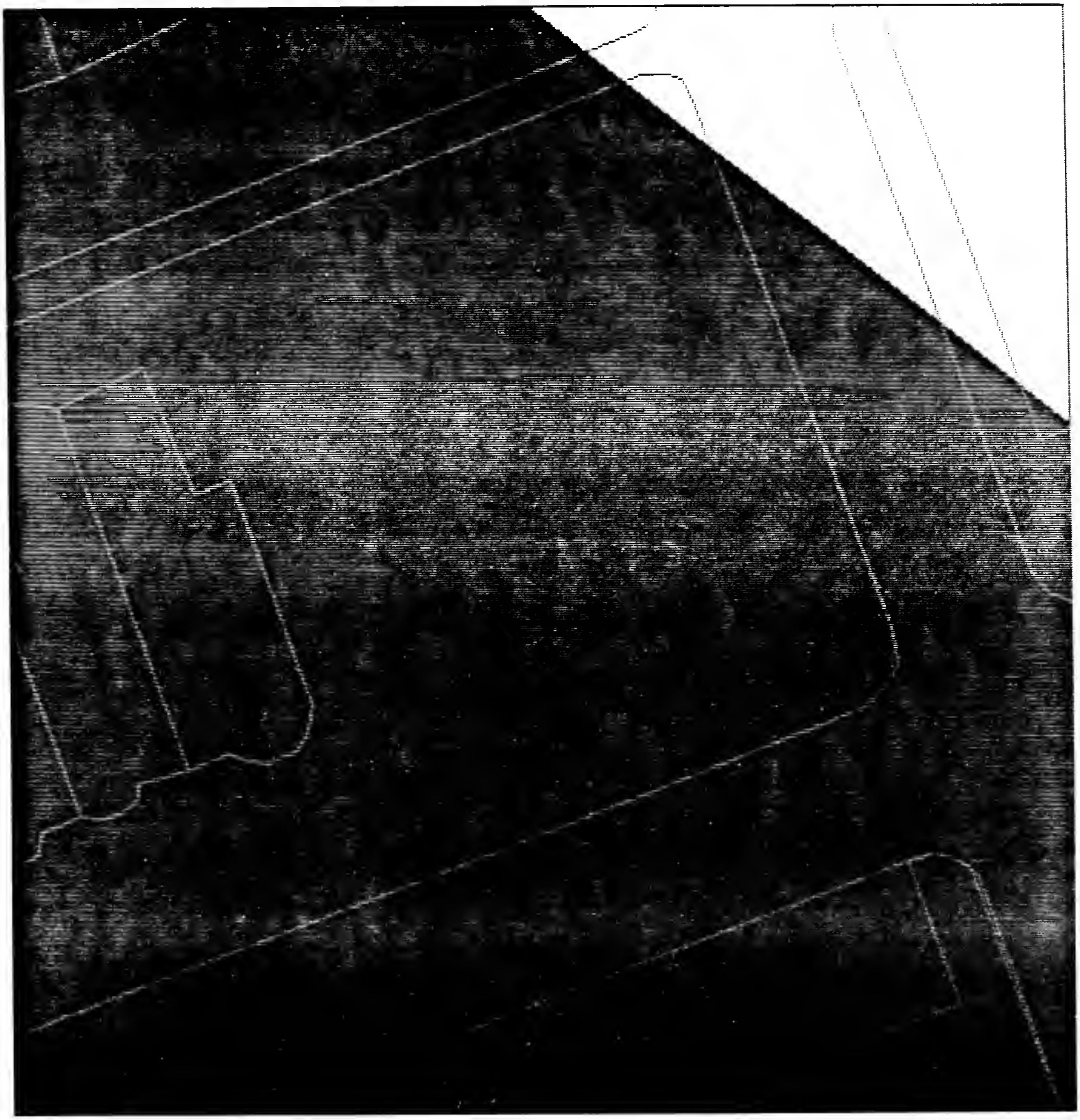
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

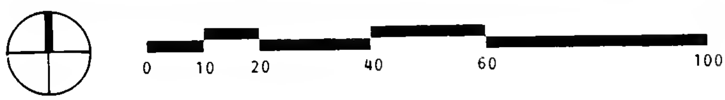
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

18 January 8:00am



Existing shadow

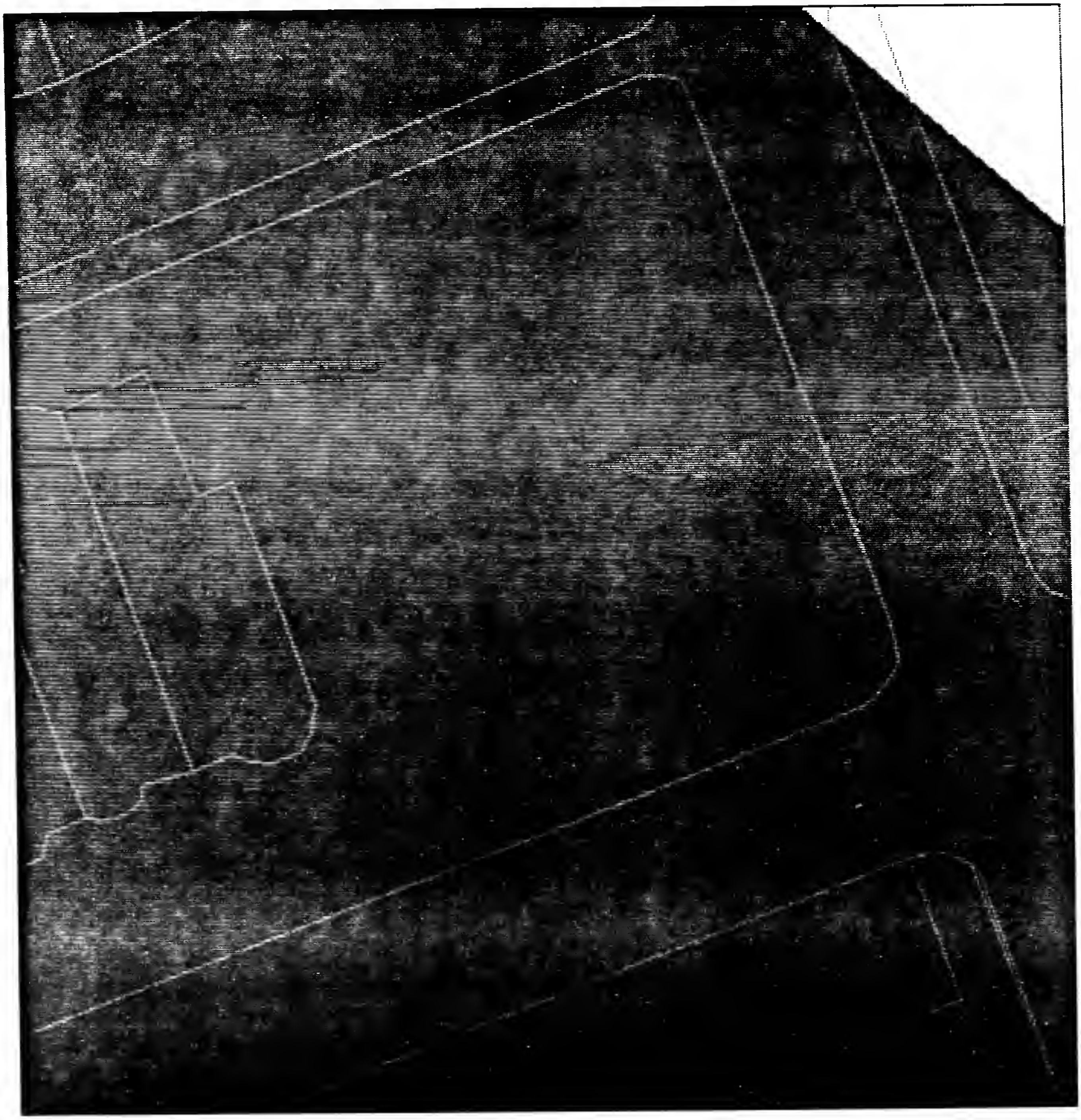
Incremental shadow
New England Life Project

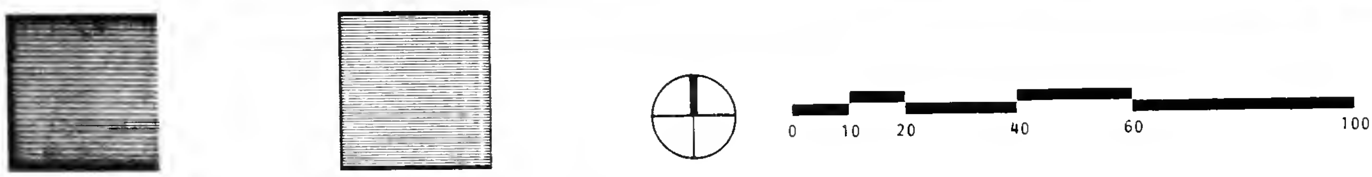


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

18 January 8:15am





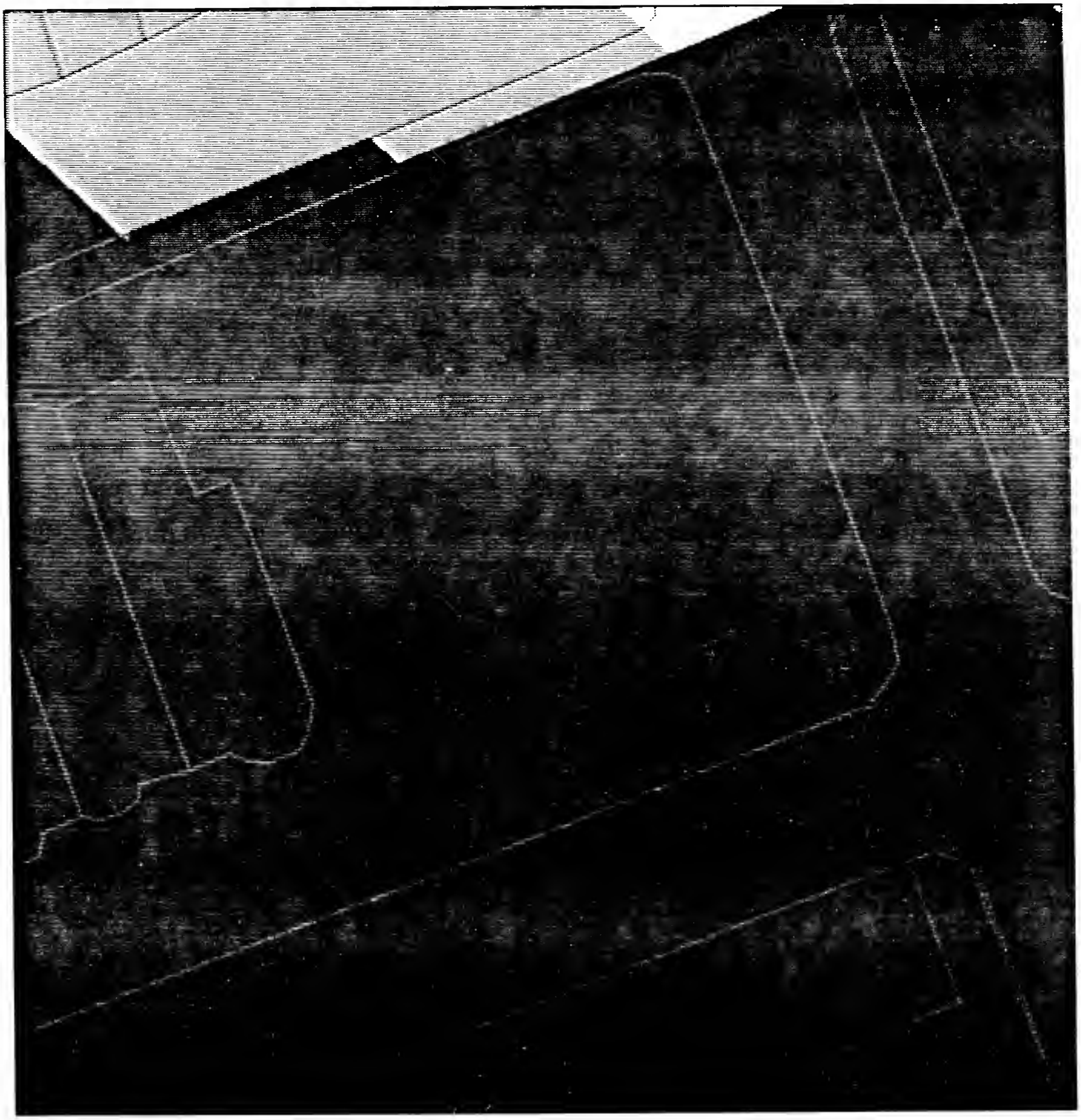
Existing shadow

Incremental shadow
New England Life Project

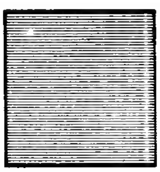
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

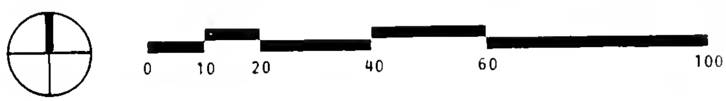
18 January 8:30am



Existing shadow



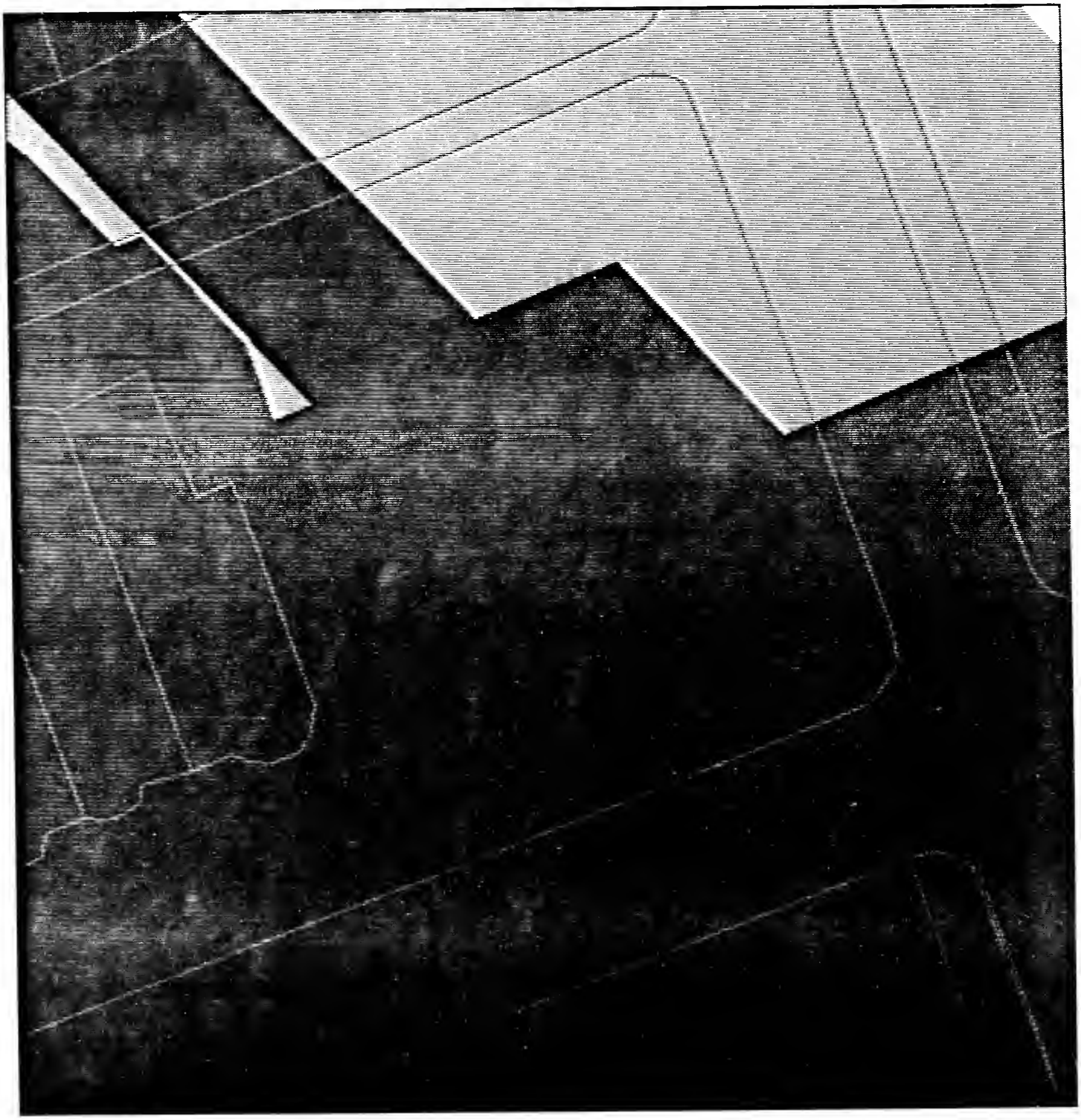
Incremental shadow
New England Life Project

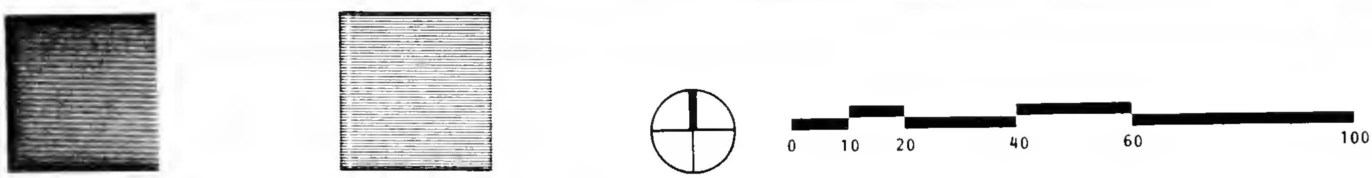


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

18 January 8:45am





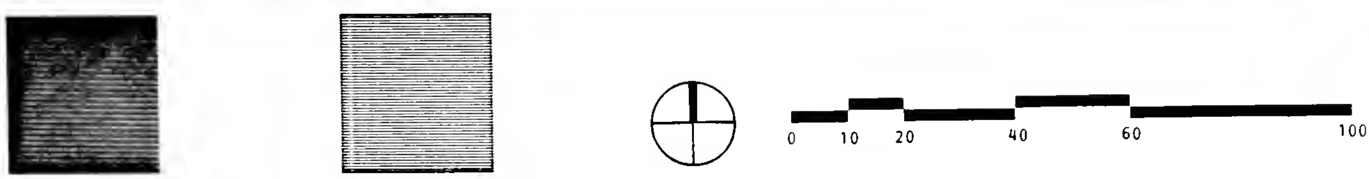
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

18 January 9:00am



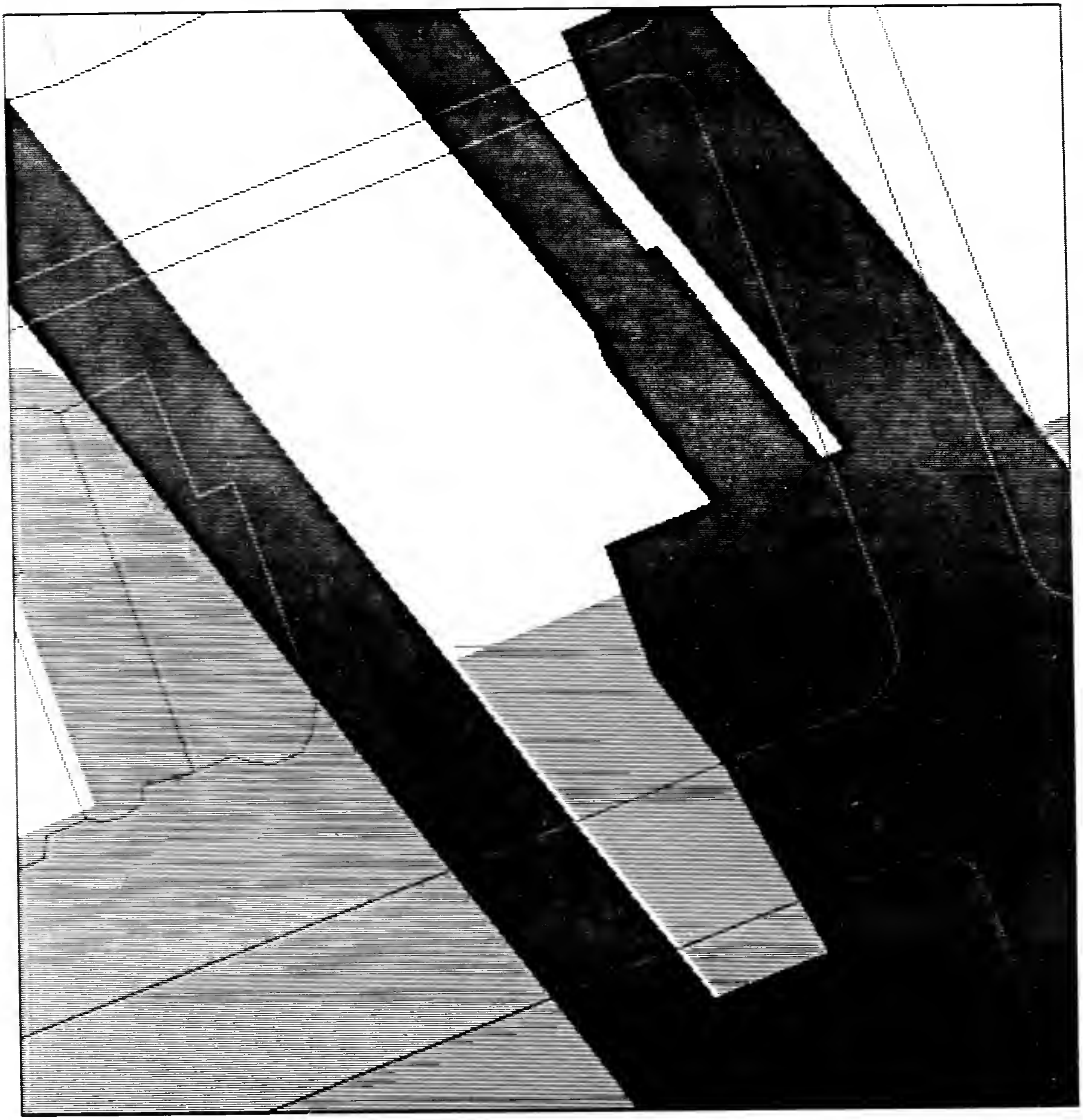
Existing shadow

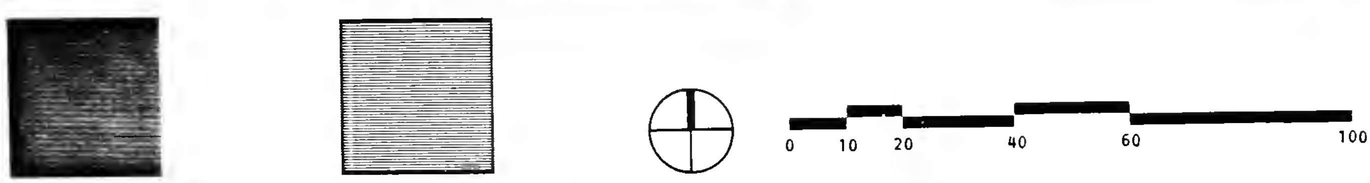
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

18 January 9:15am





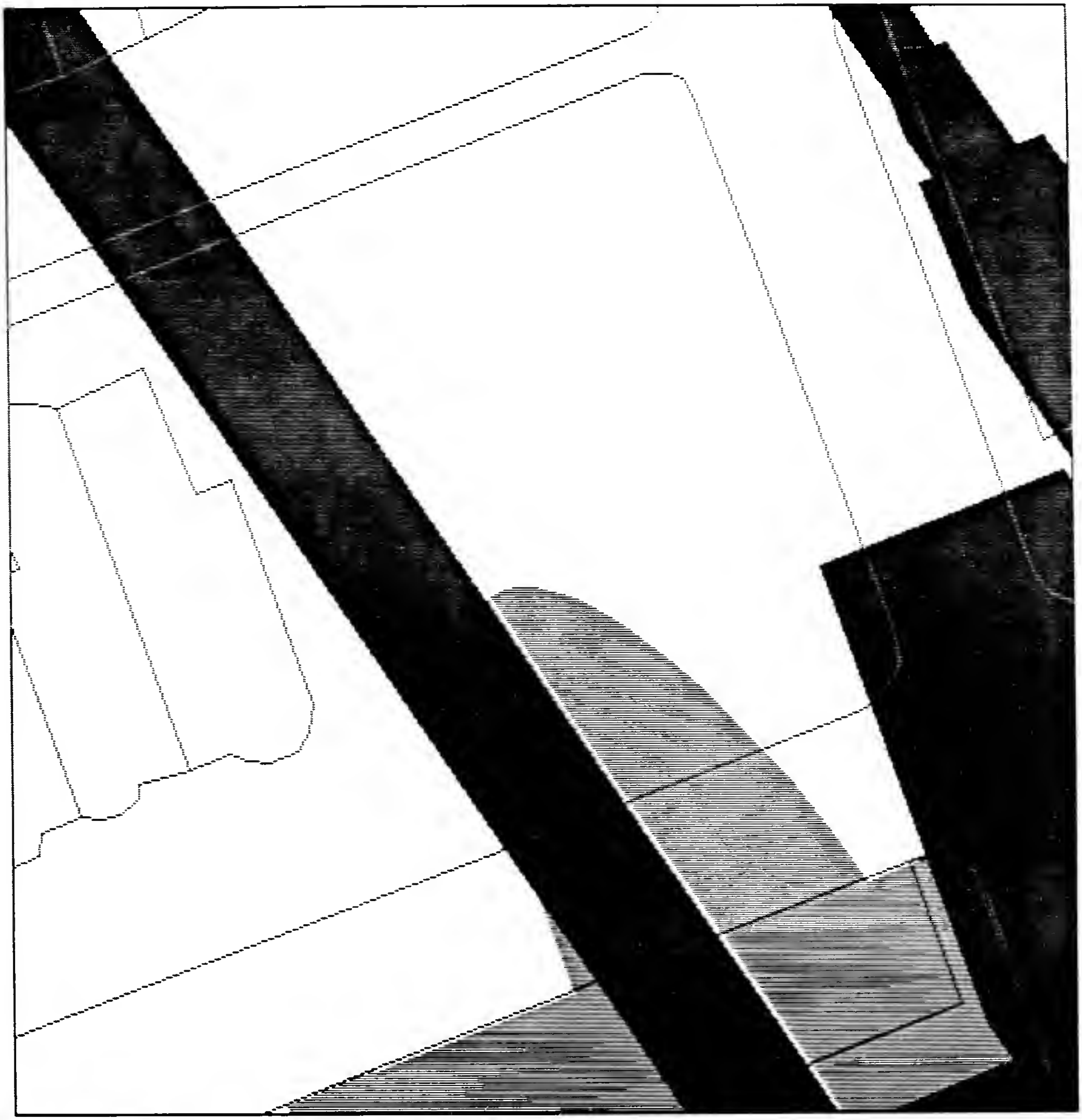
Existing shadow

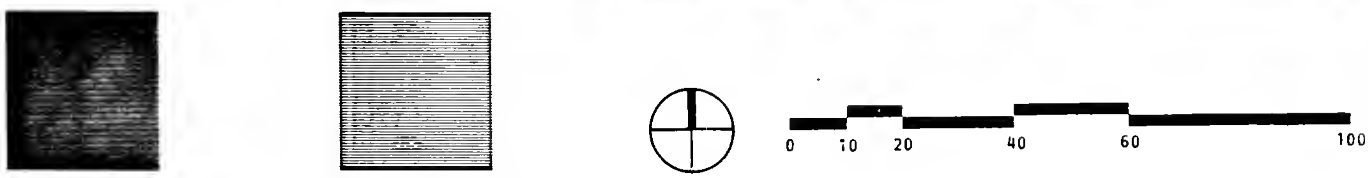
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

18 January 9:30am





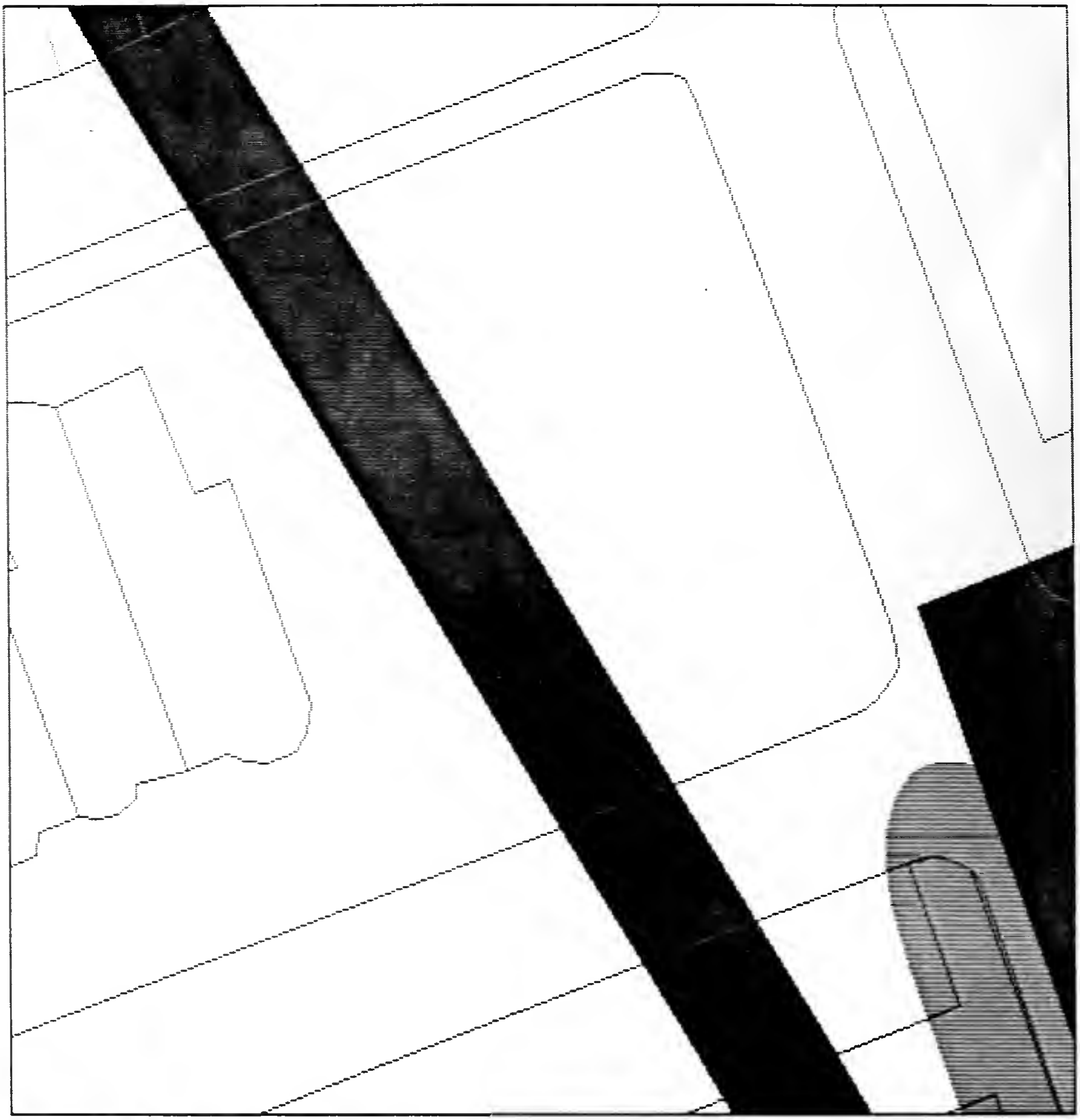
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

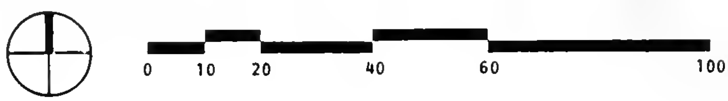
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

18 January 9:45am



Existing shadow

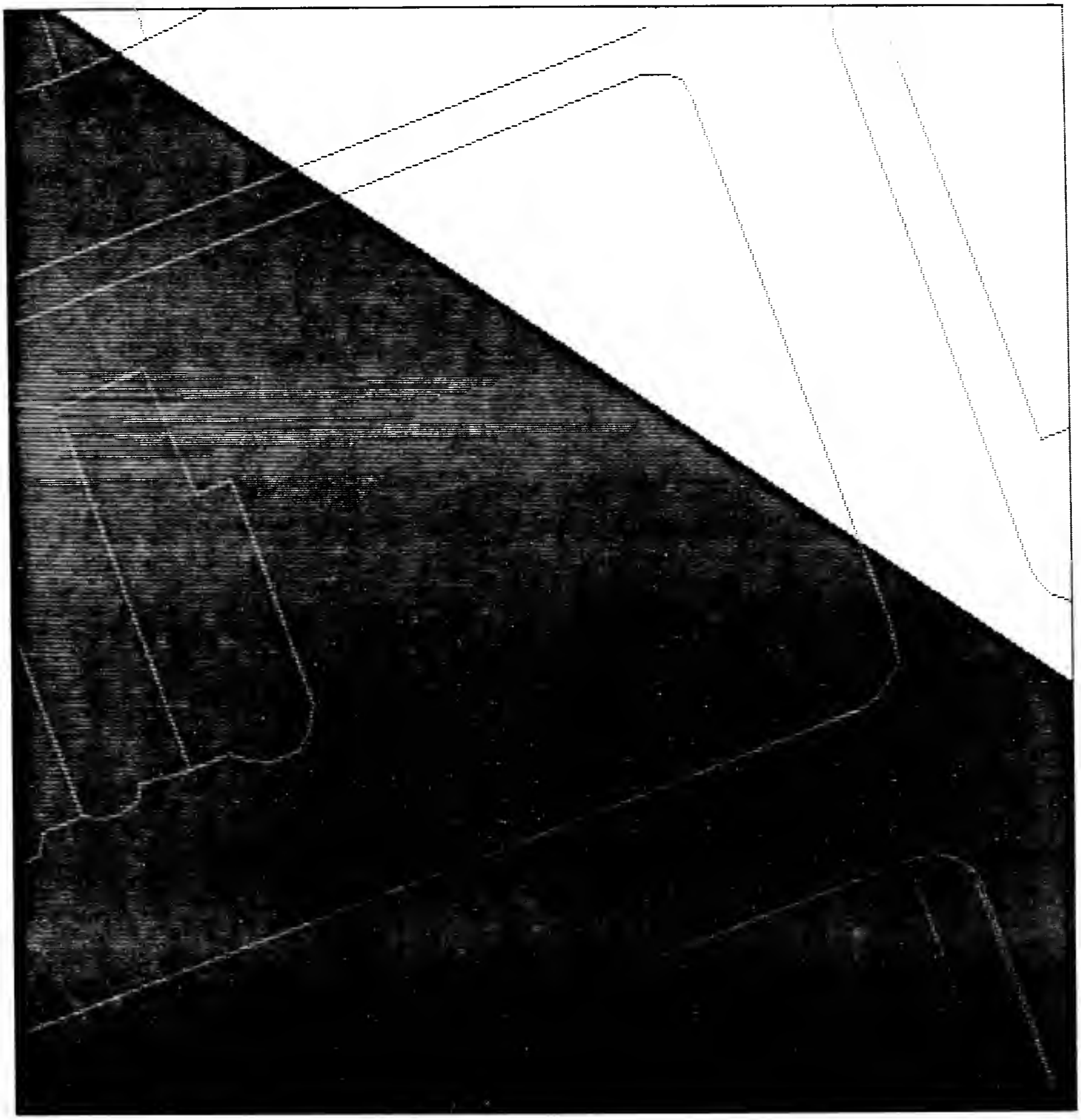
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

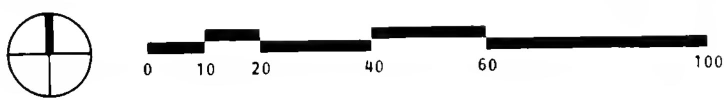
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

25 January 7:45am



Existing shadow

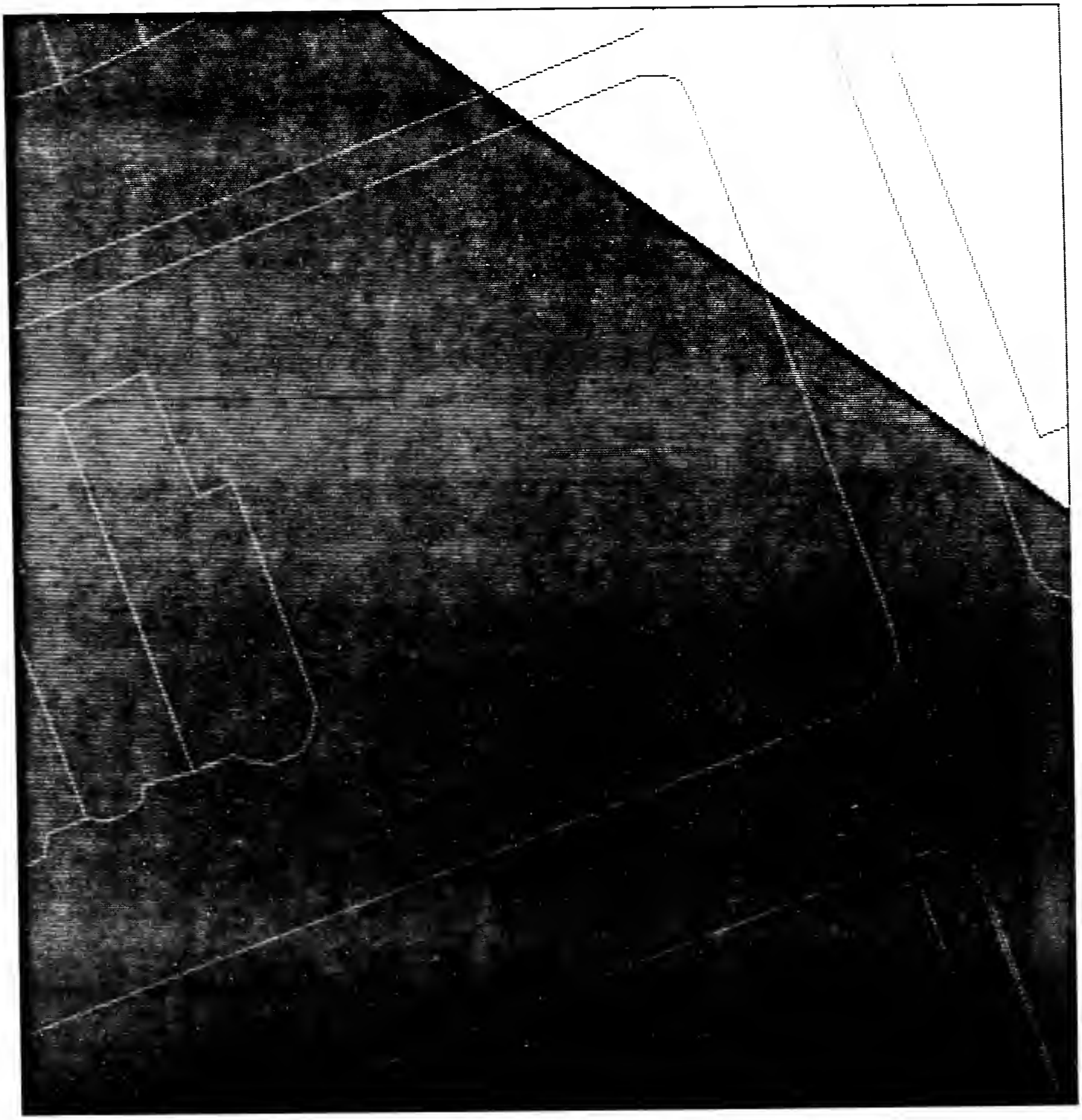
Incremental shadow
New England Life Project



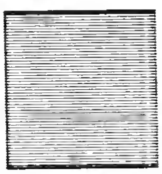
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

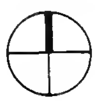
25 January 8:00am



Existing shadow



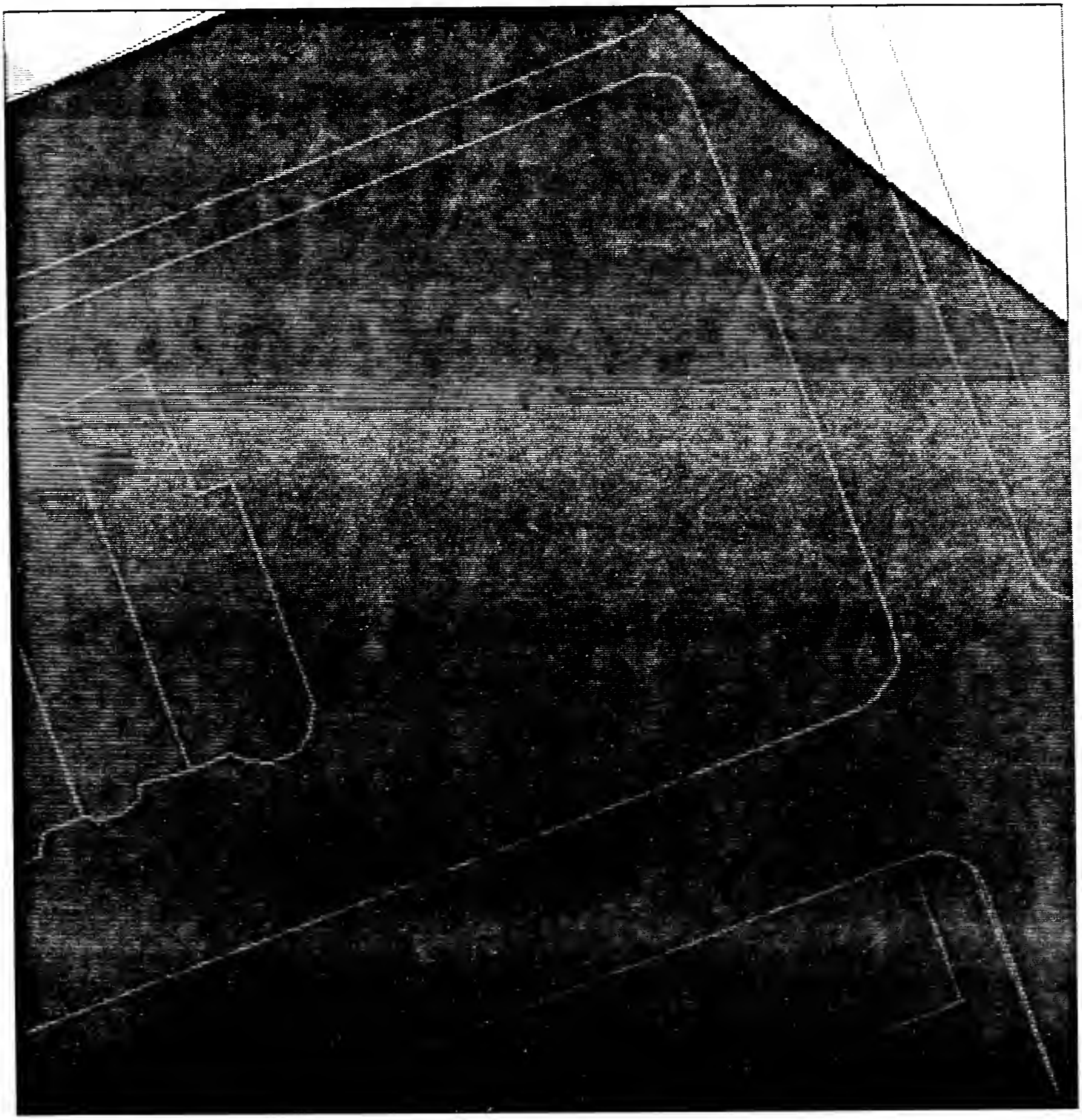
Incremental shadow
New England Life Project

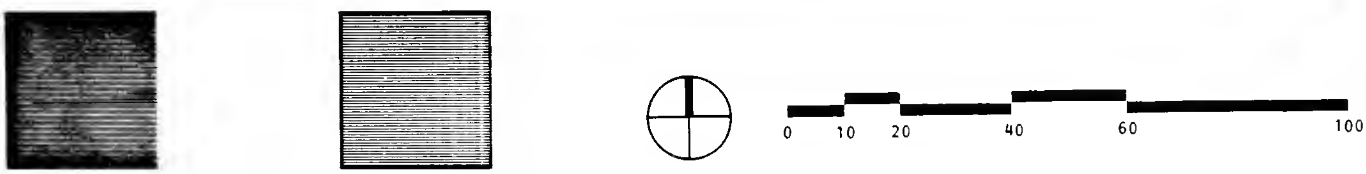


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

25 January 8:15am





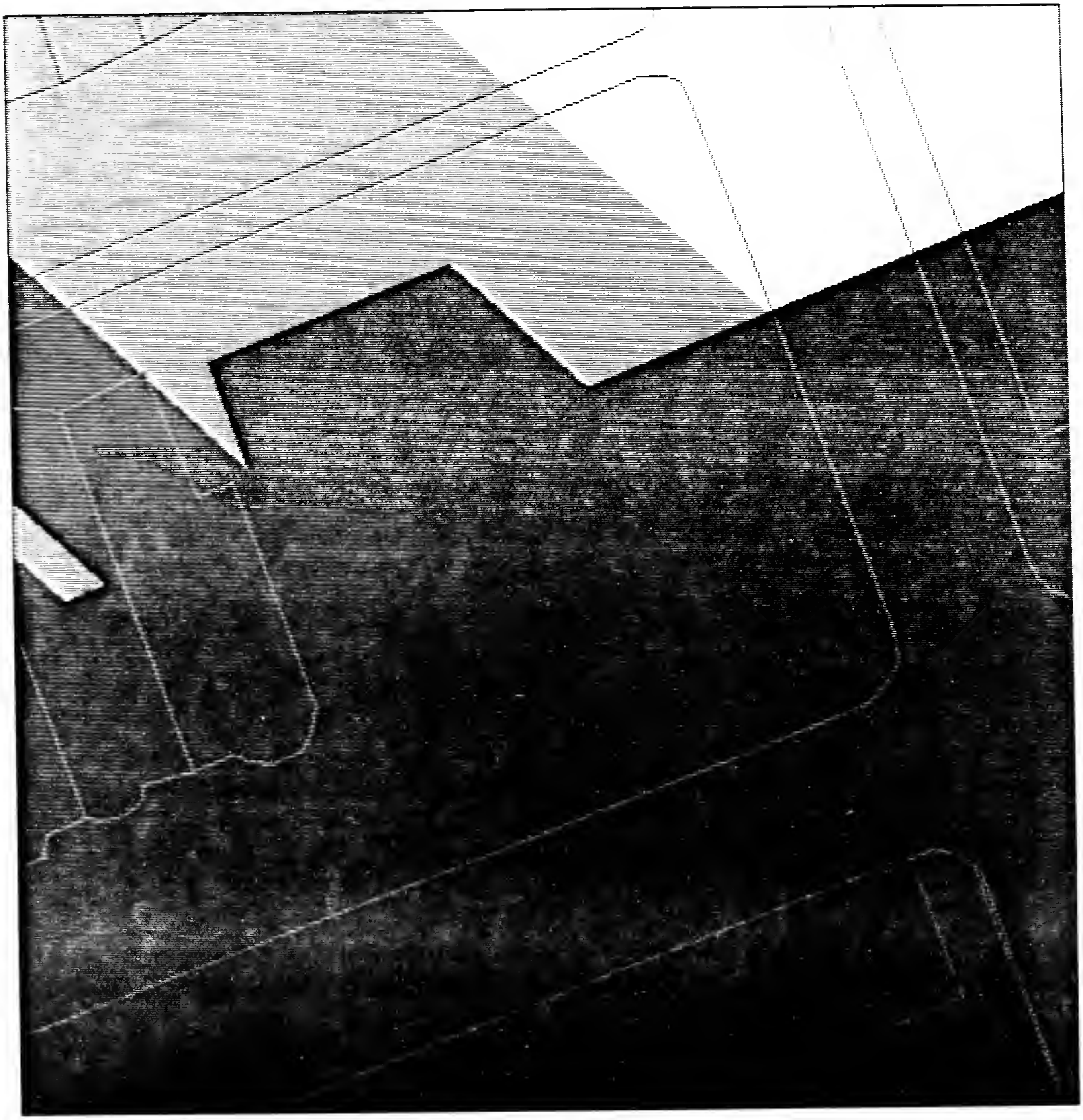
Existing shadow

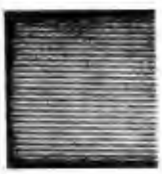
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

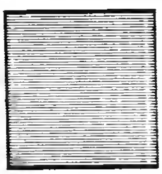
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

25 January 8:30am

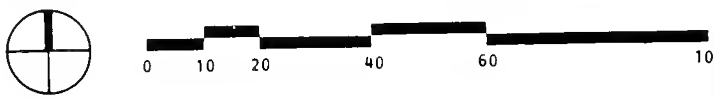




Existing shadow



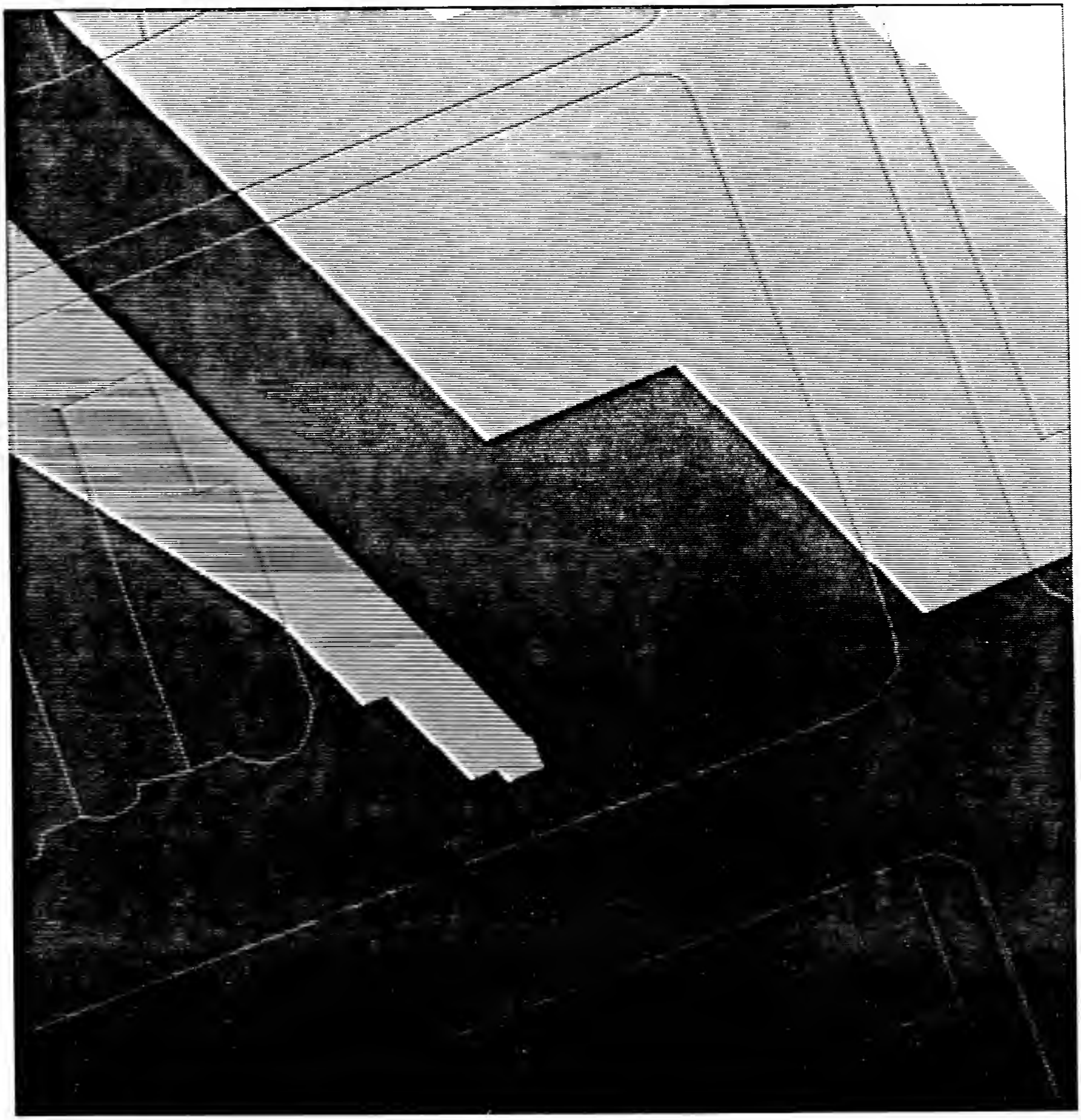
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

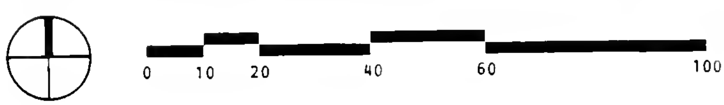
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

25 January 8:45am



Existing shadow

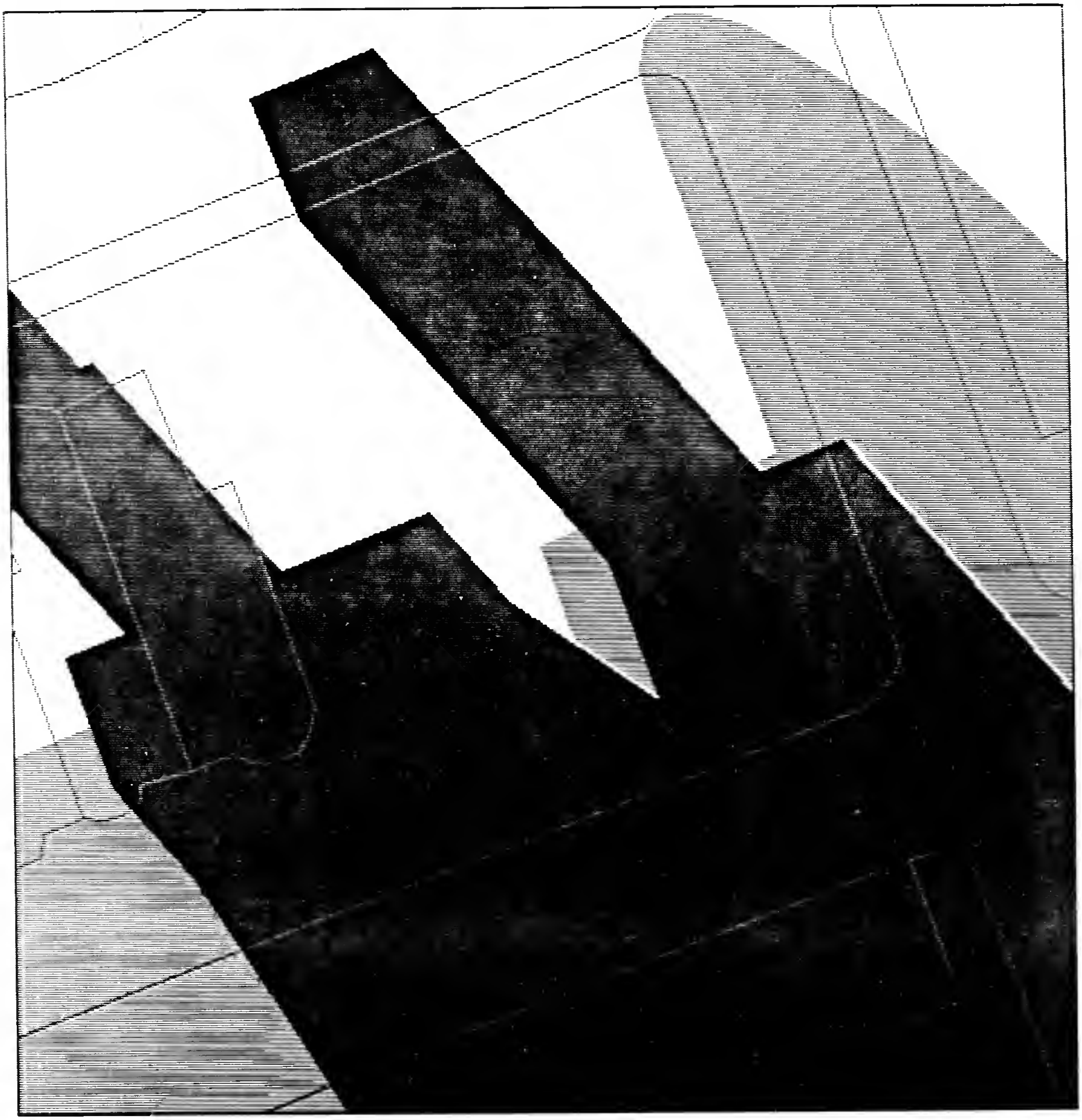
Incremental shadow
New England Life Project

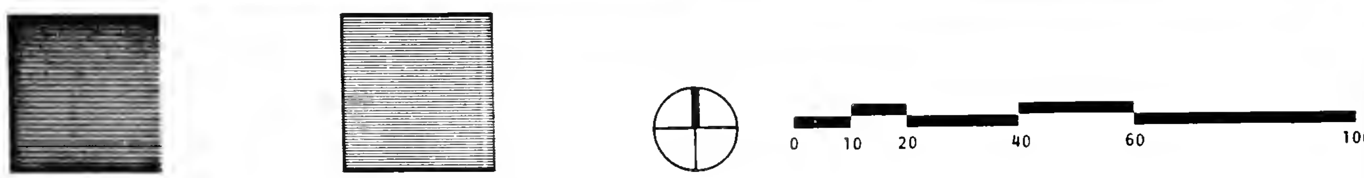


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

25 January 9:00am





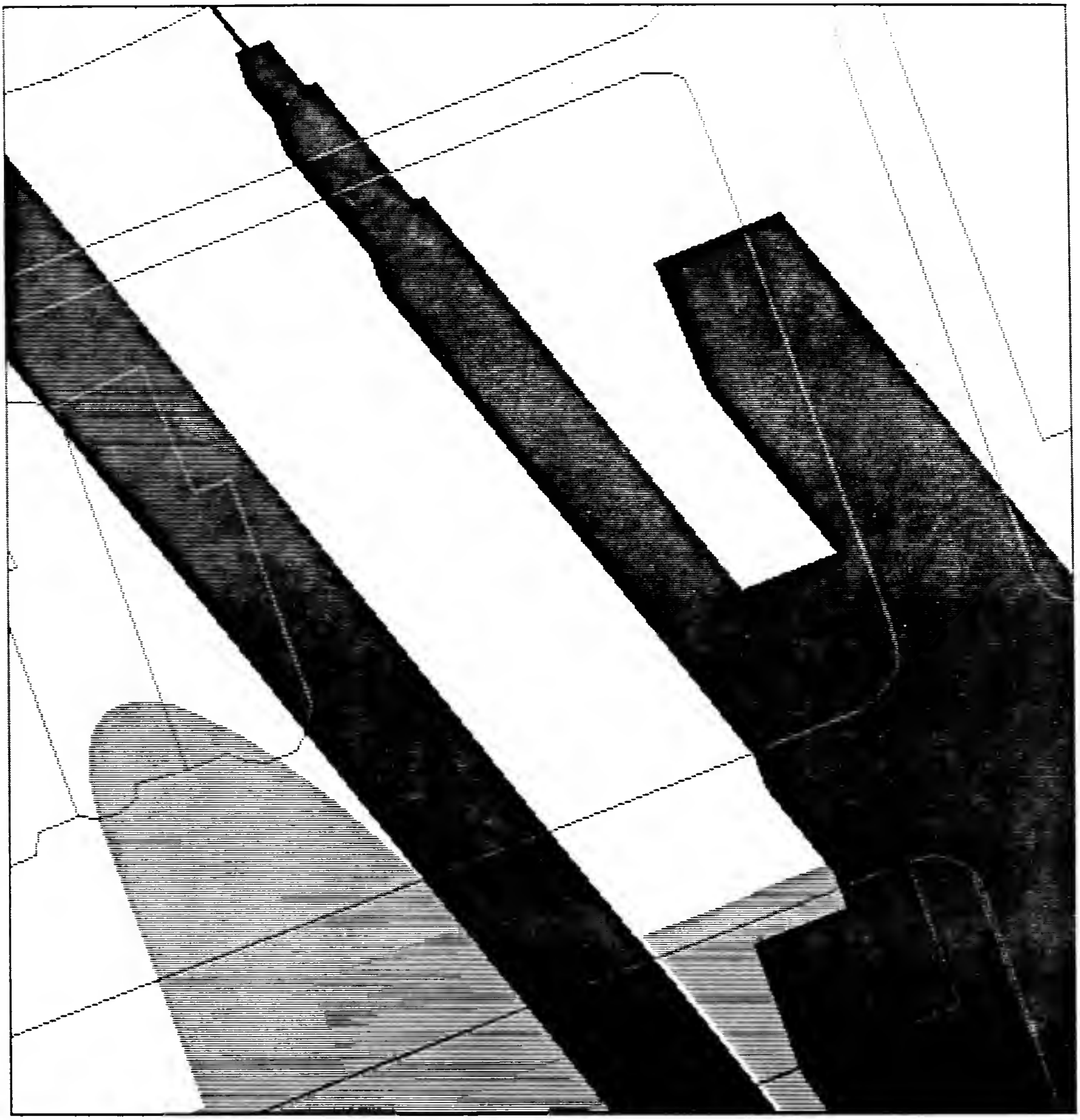
Existing shadow

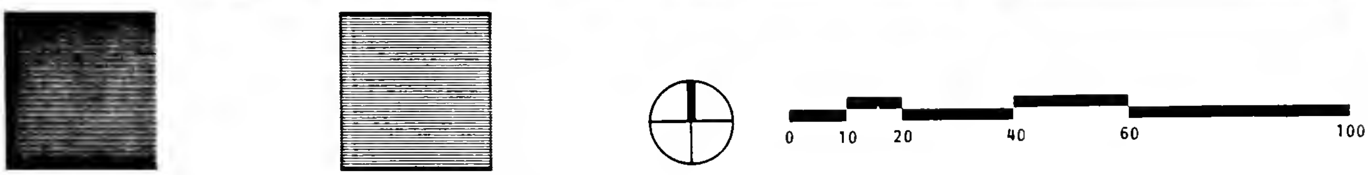
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

25 January 9:15am





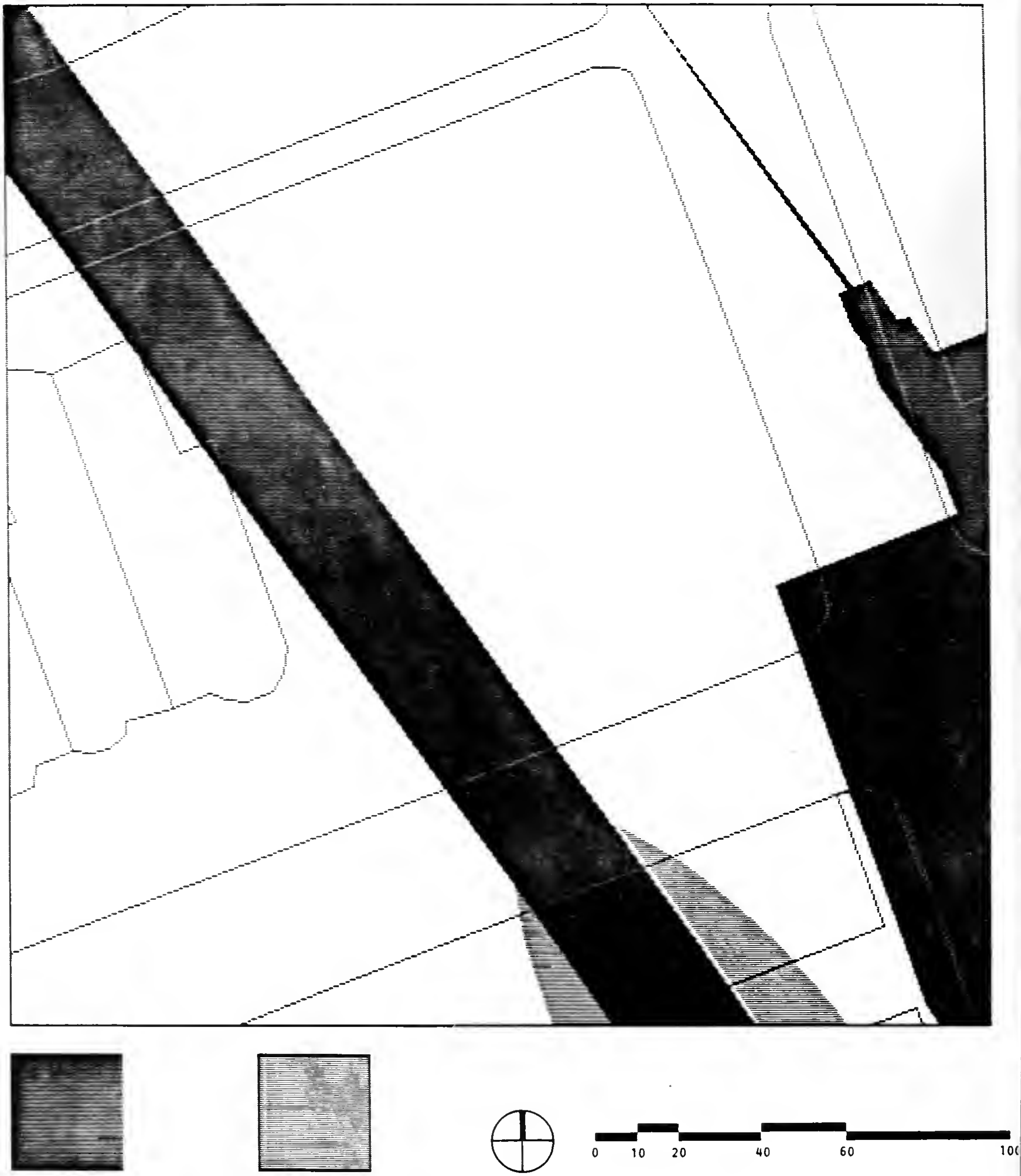
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

25 January 9:30am



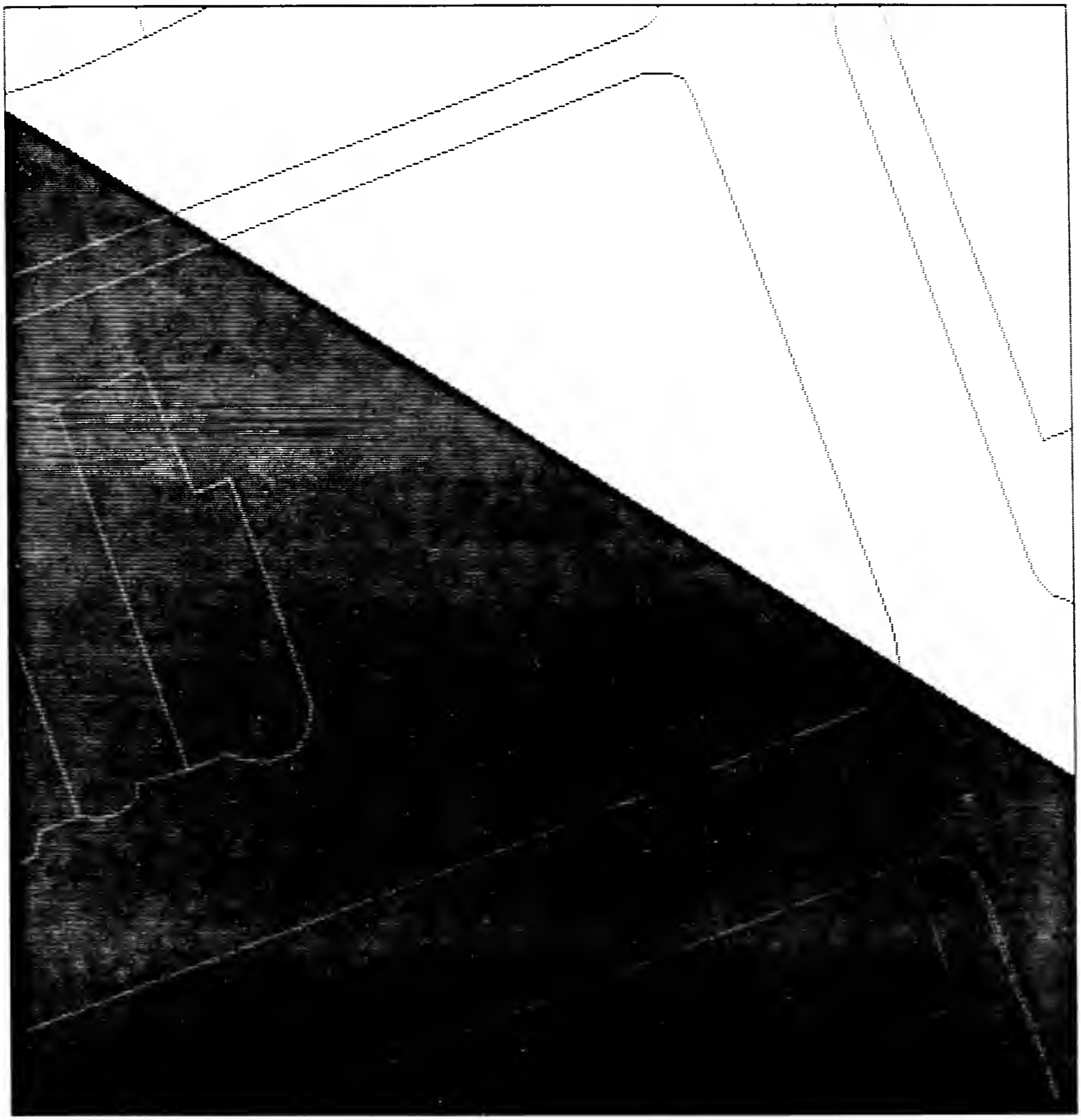
Existing shadow

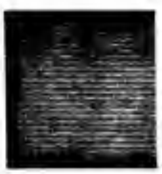
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

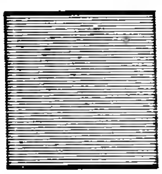
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

1 February 7:45am

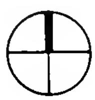




Existing shadow



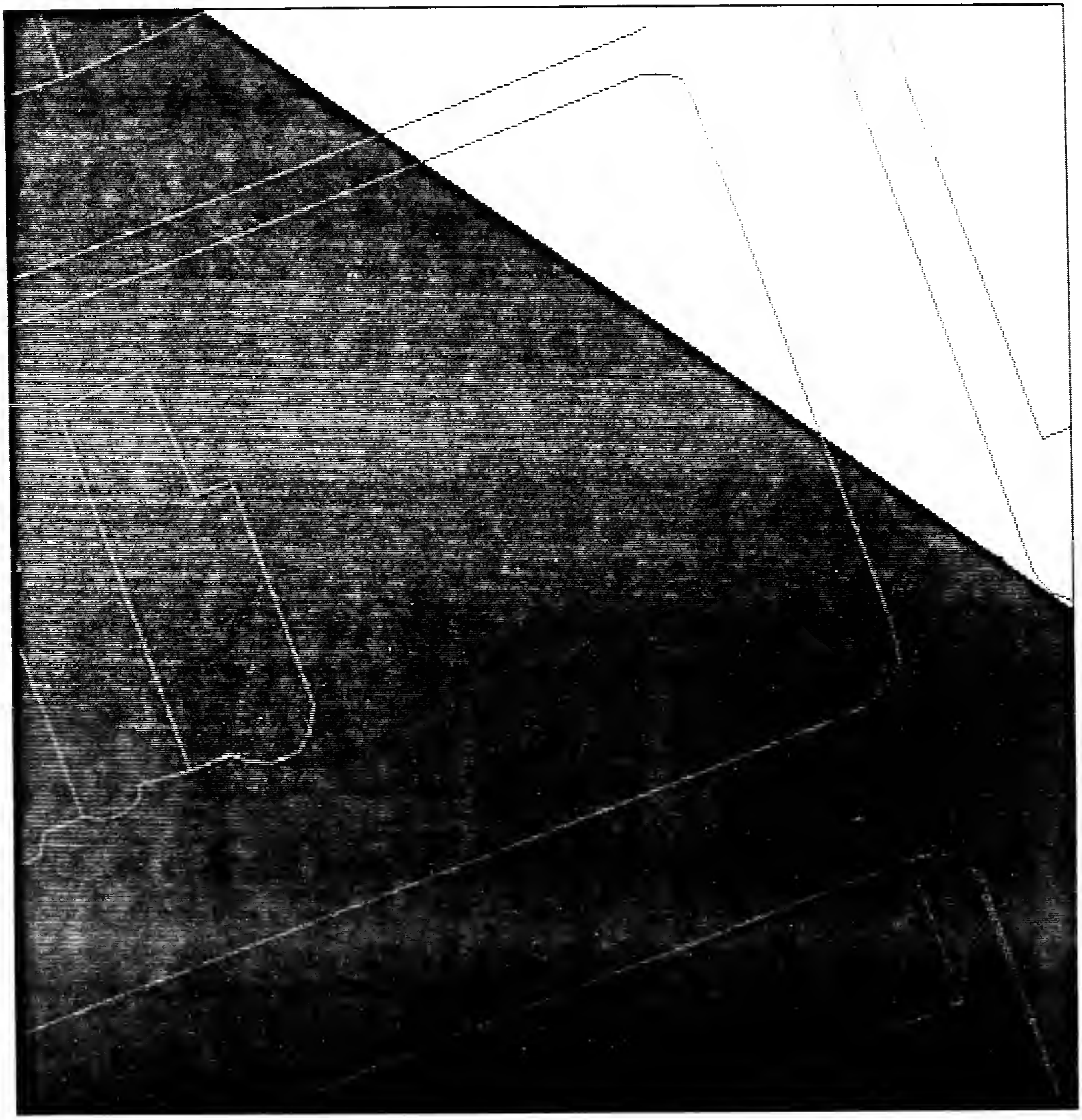
Incremental shadow
New England Life Project

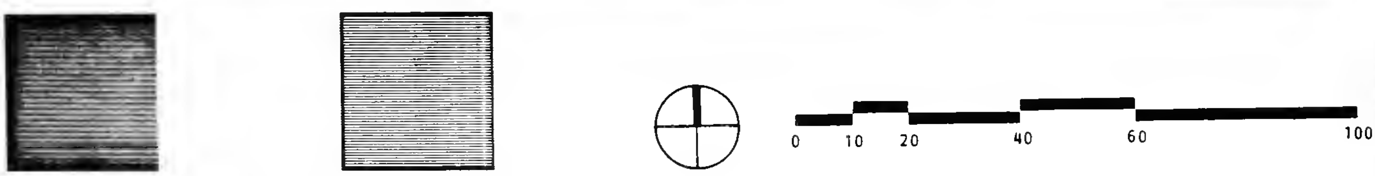


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

1 February 8:00am





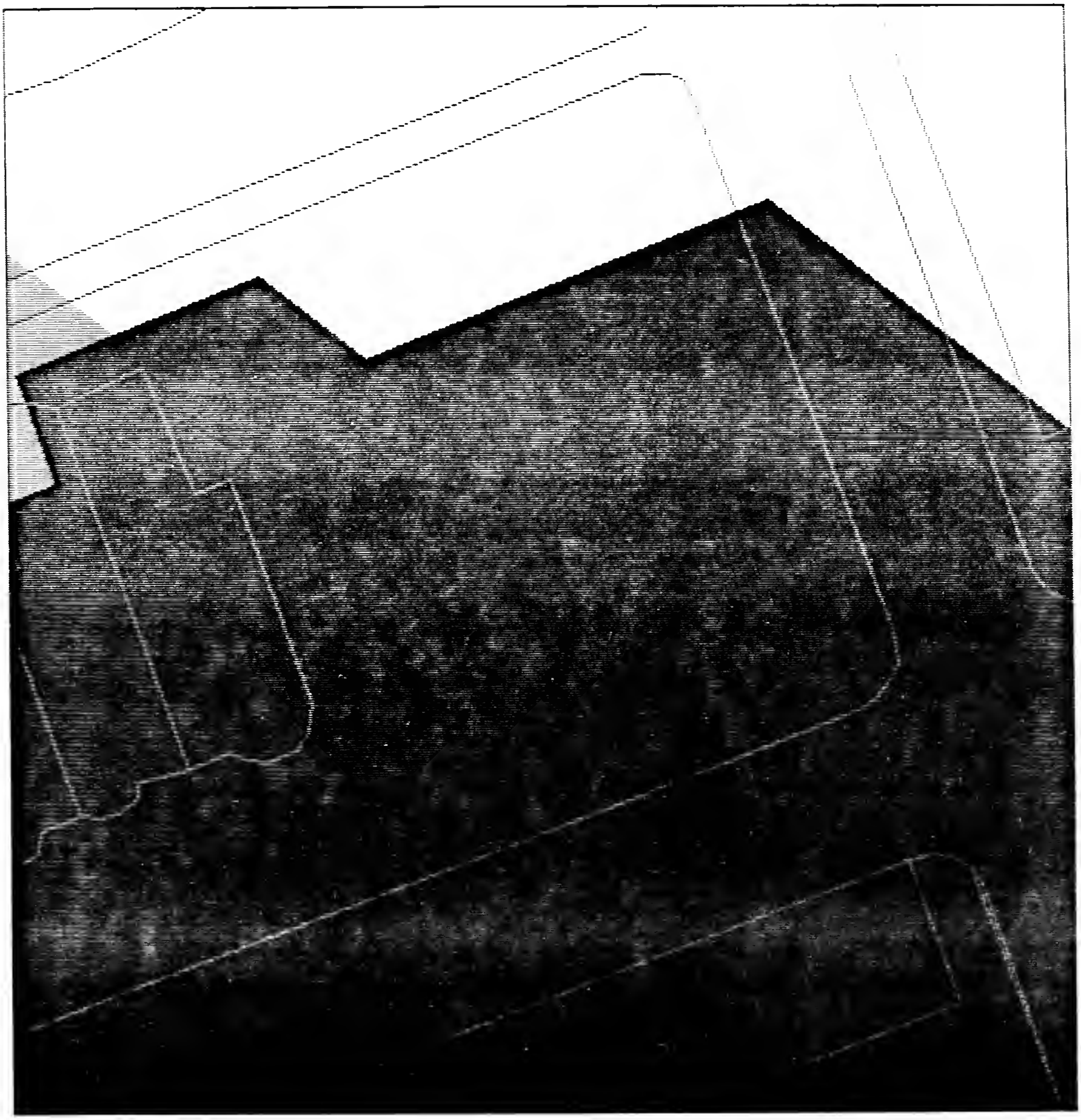
Existing shadow

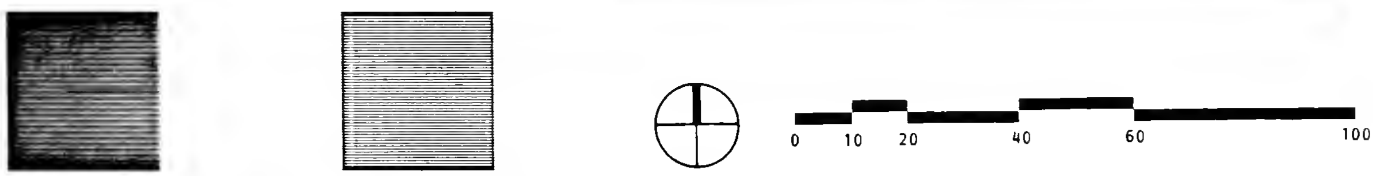
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

1 February 8:15am





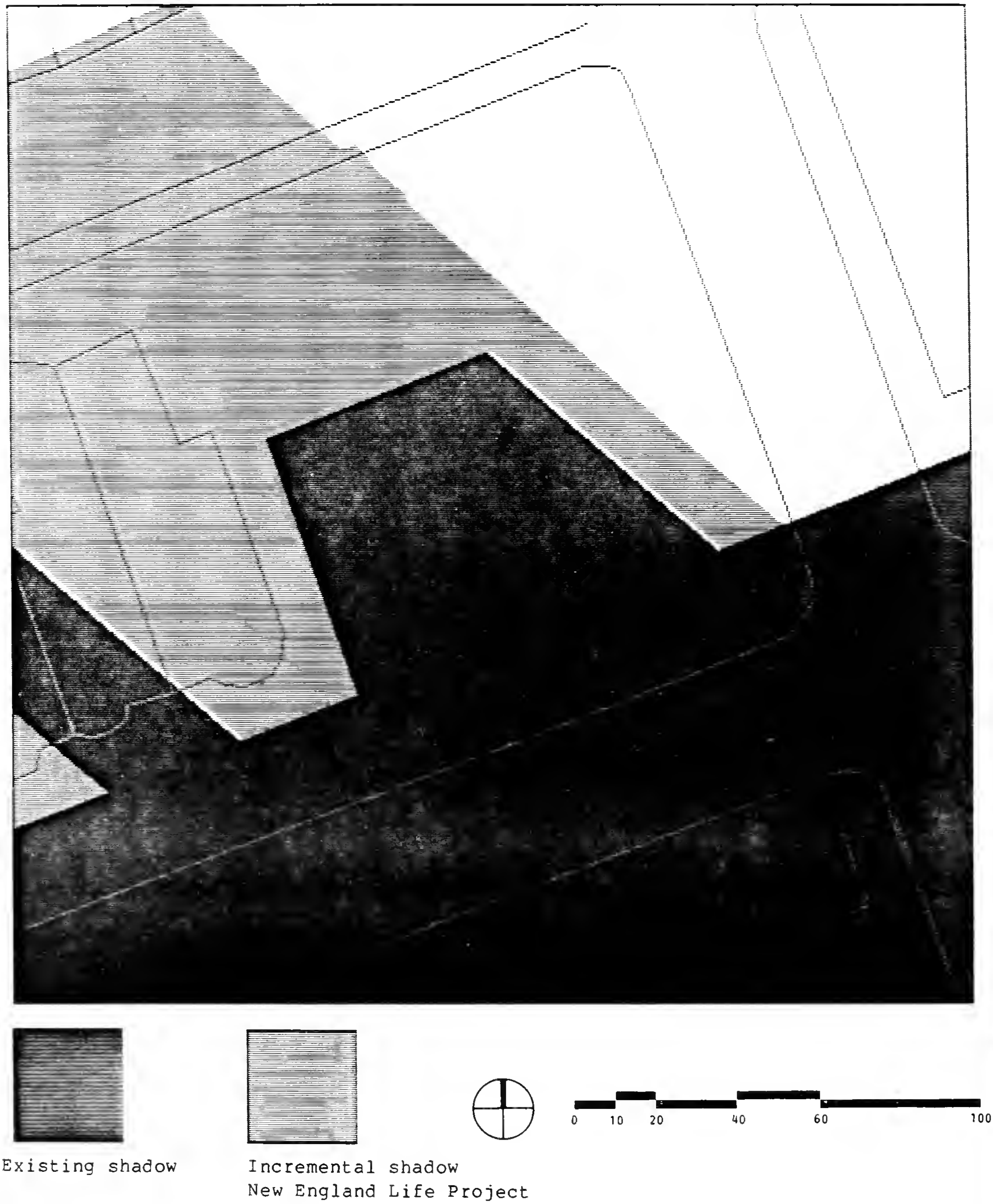
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

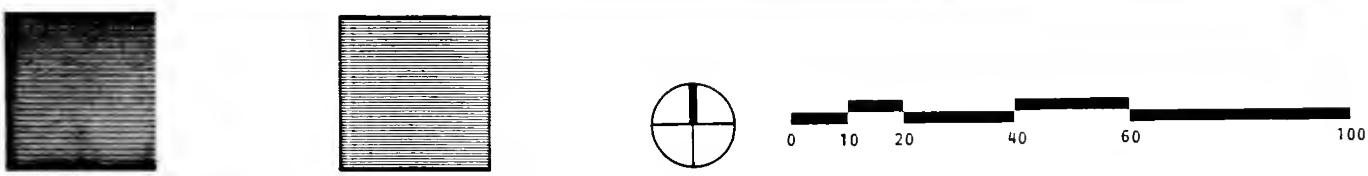
1 February 8:30am



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

1 February 8:45am



Existing shadow

Incremental shadow
New England Life Project

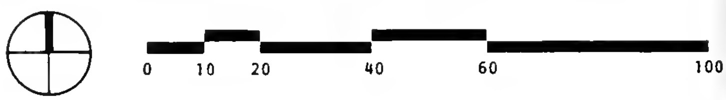
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

1 February 9:00am

Existing shadow

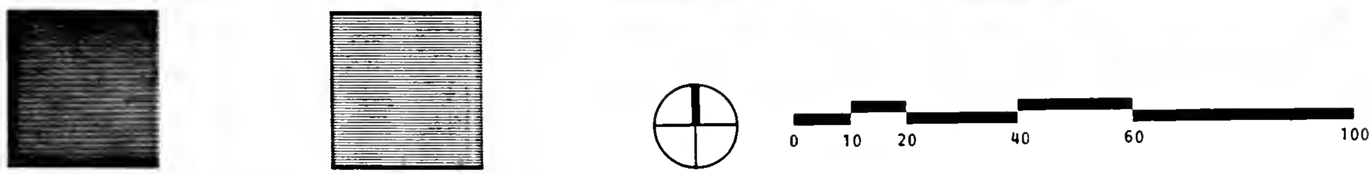
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

1 February 9:15am



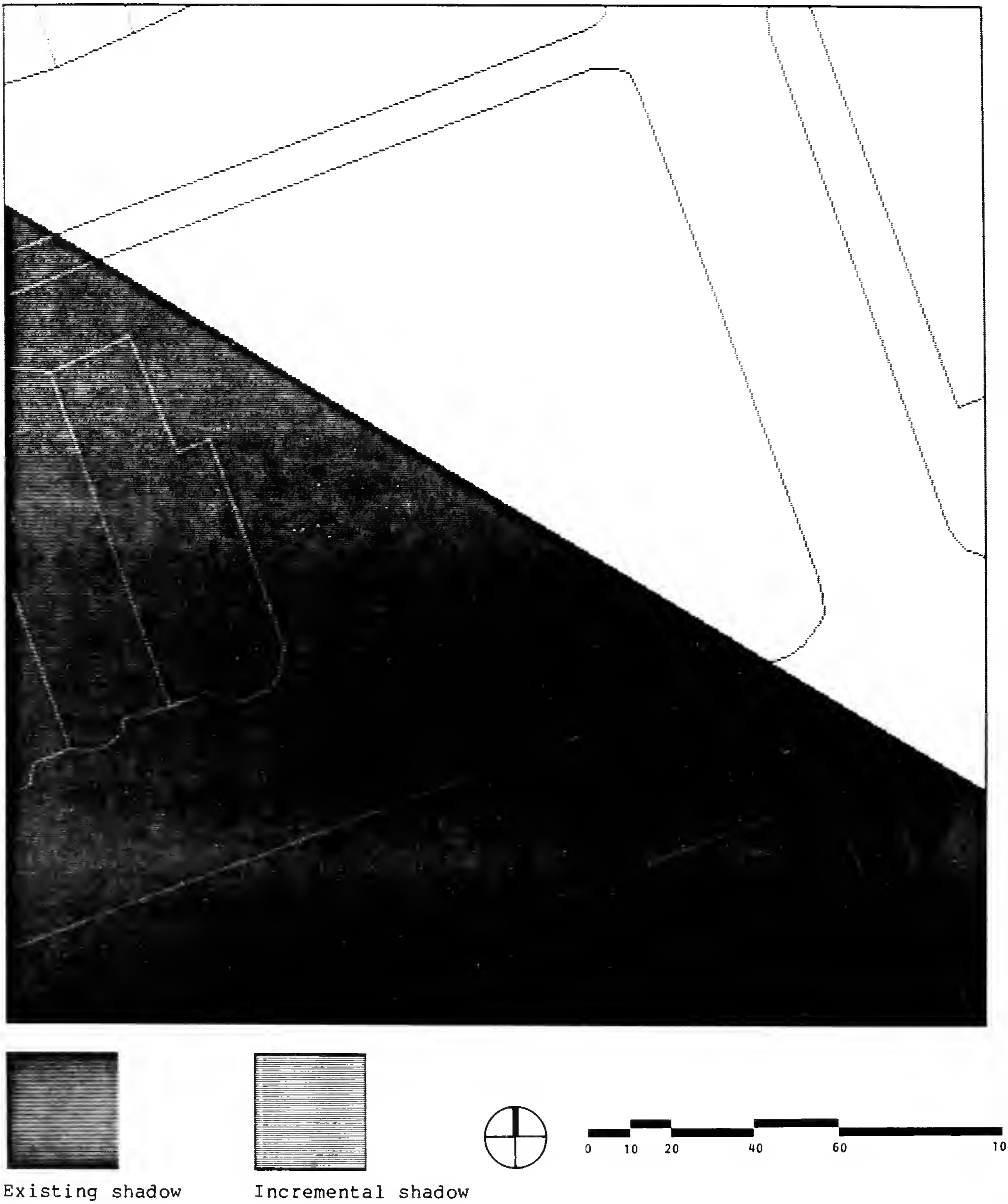
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

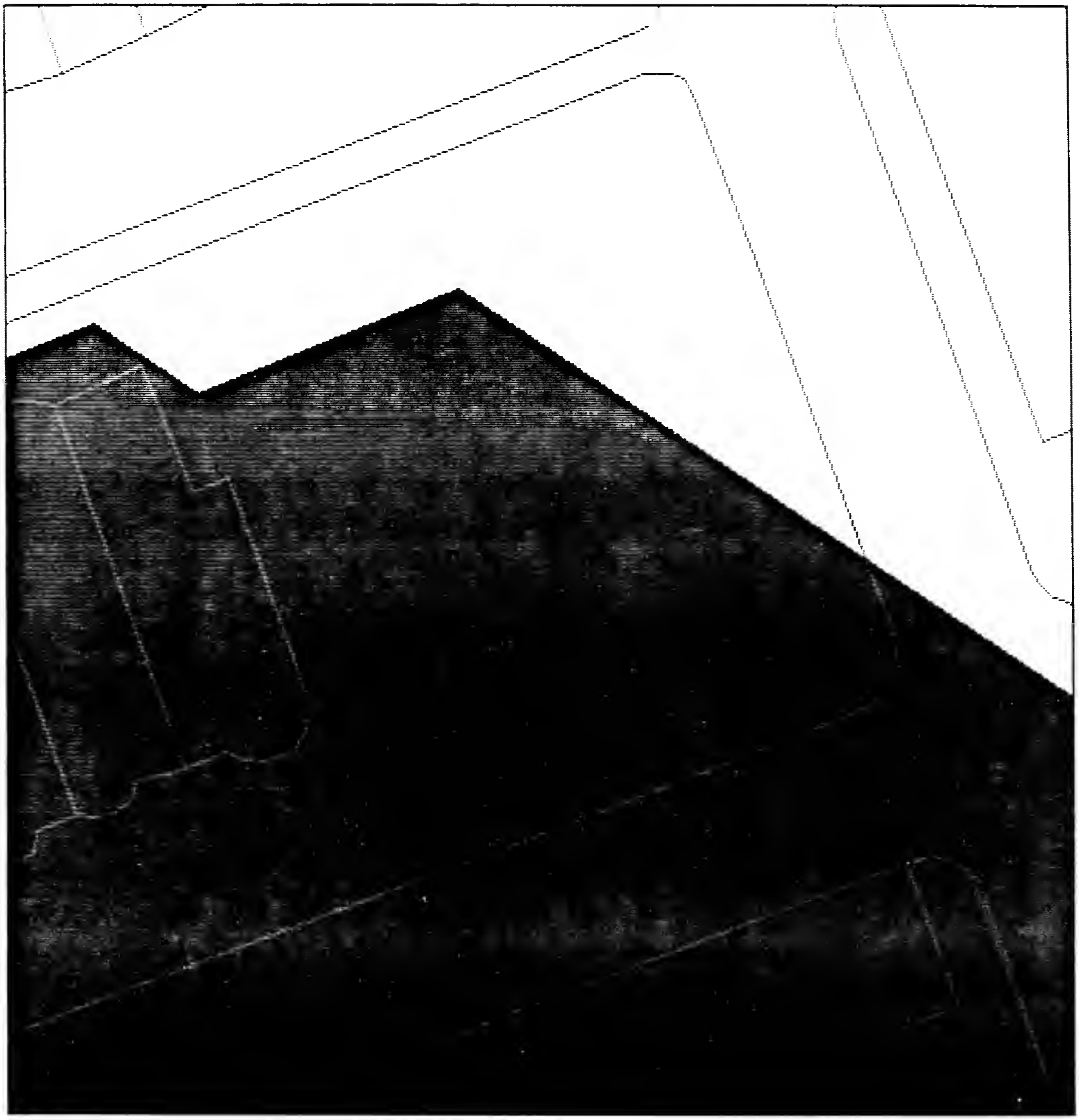
8 February 7:45am

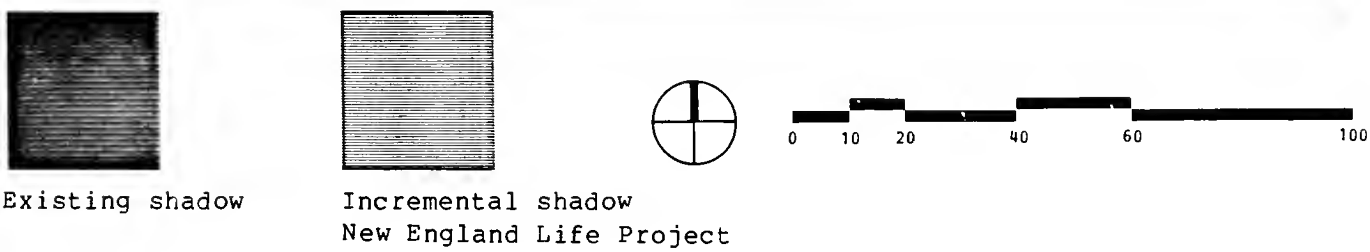


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

8 February 8:00am

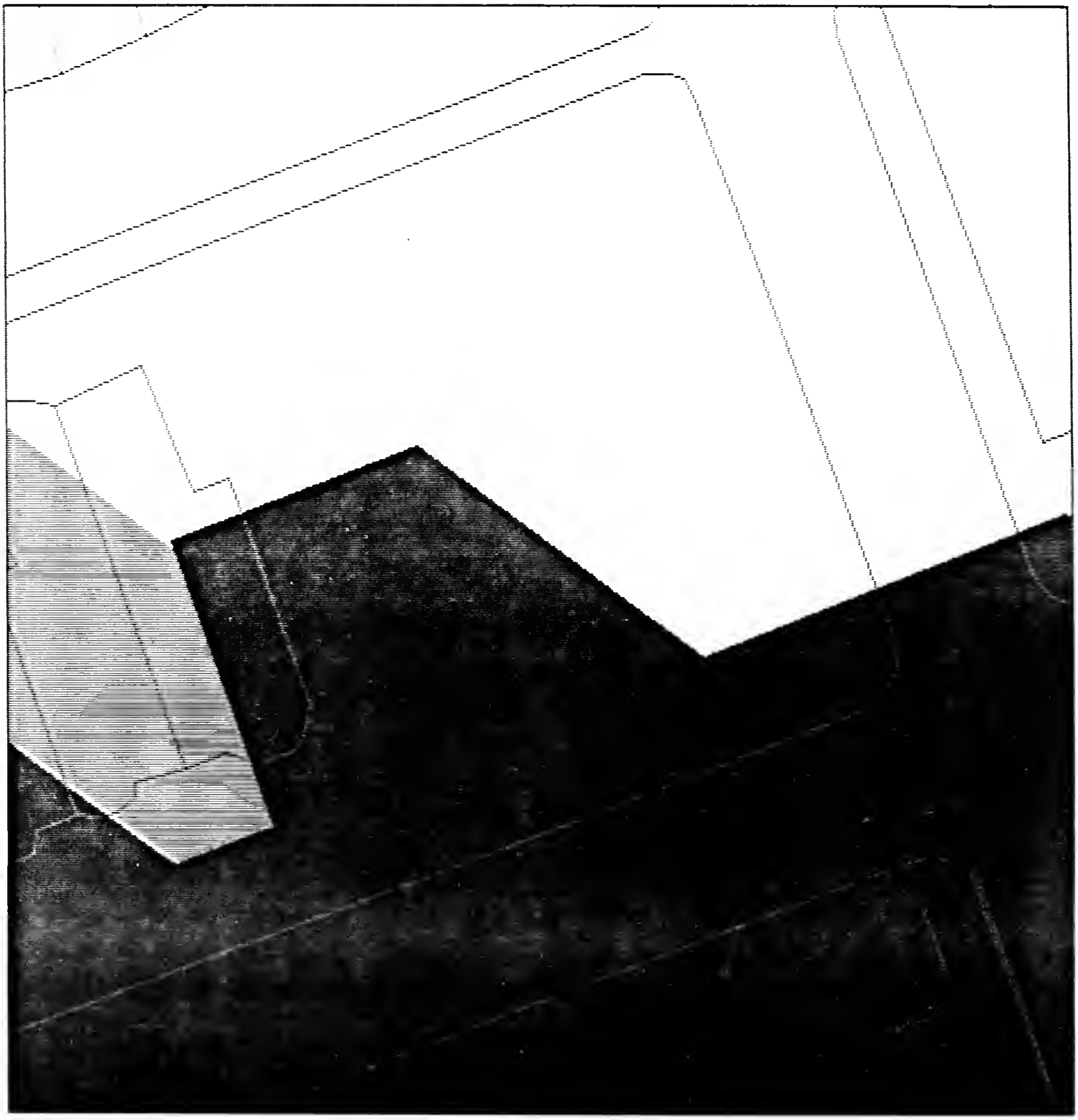


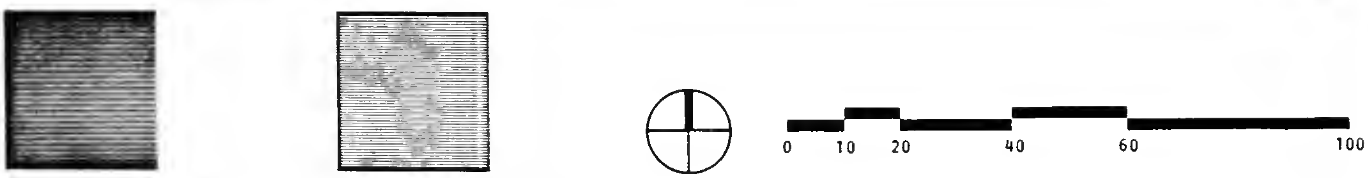


- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

8 February 8:15am





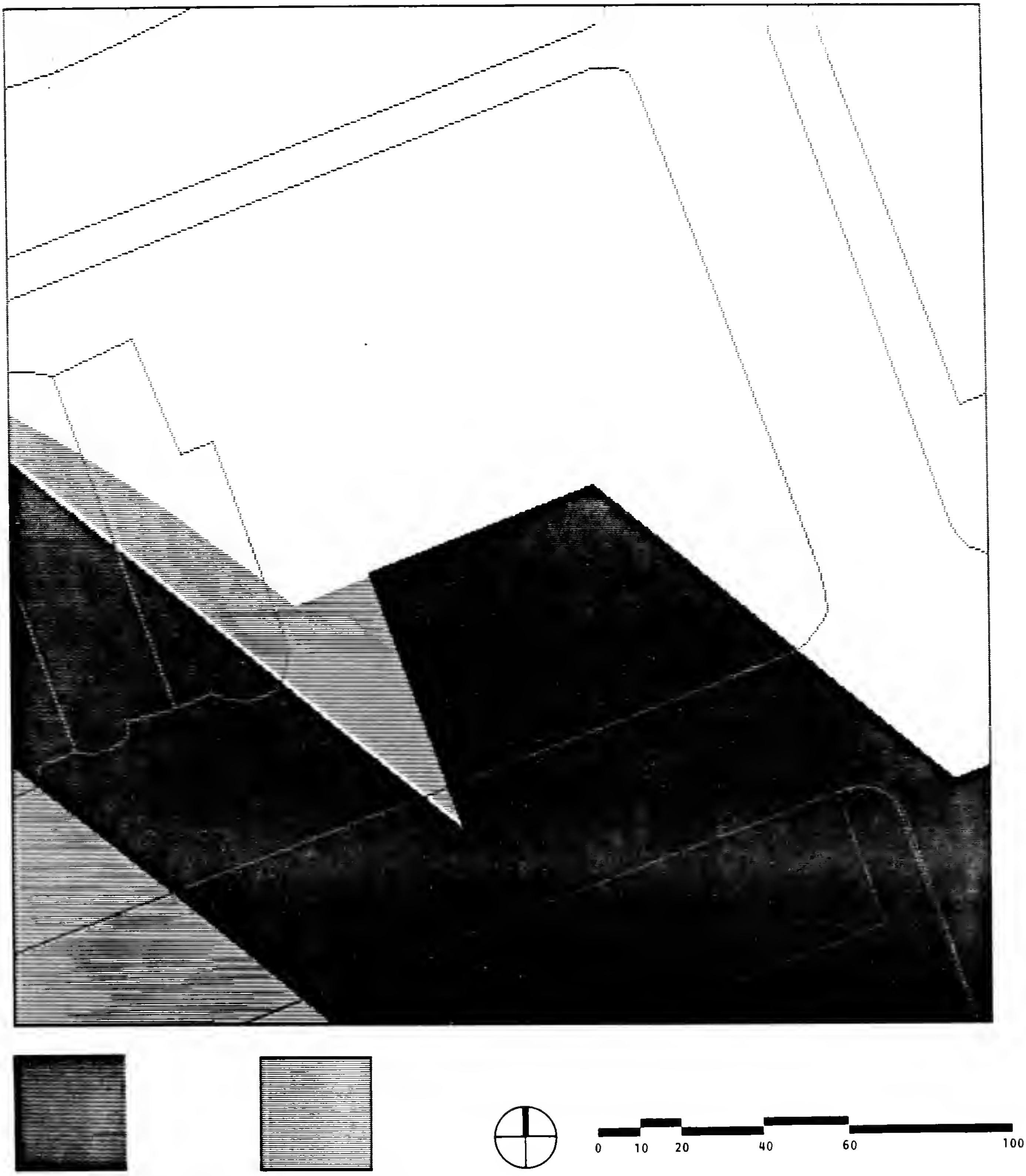
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

8 February 8:30am



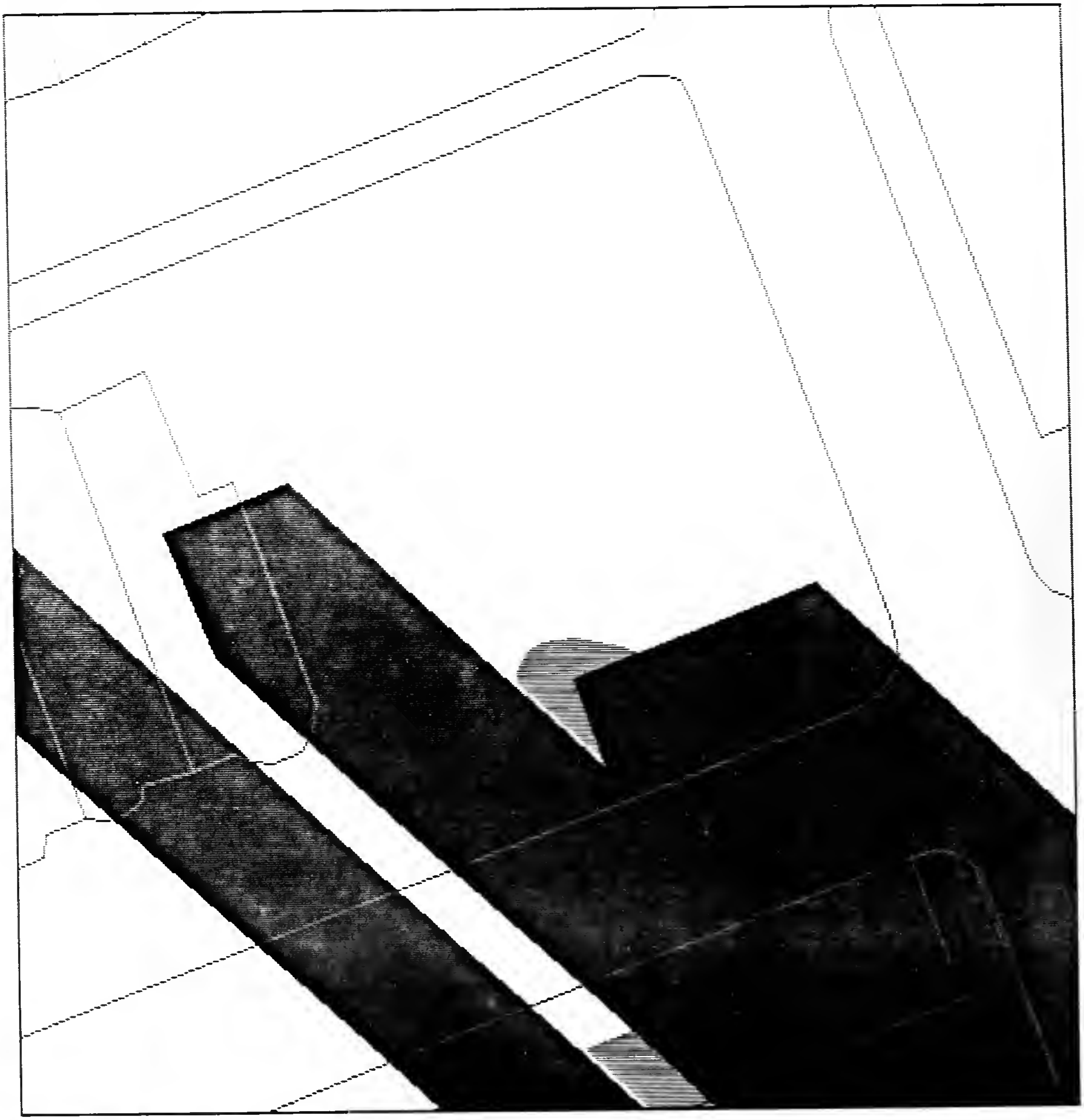
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

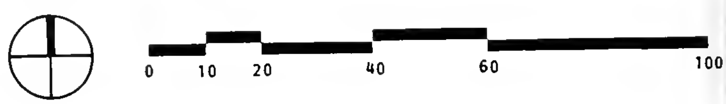
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

8 February 8:45am



Existing shadow

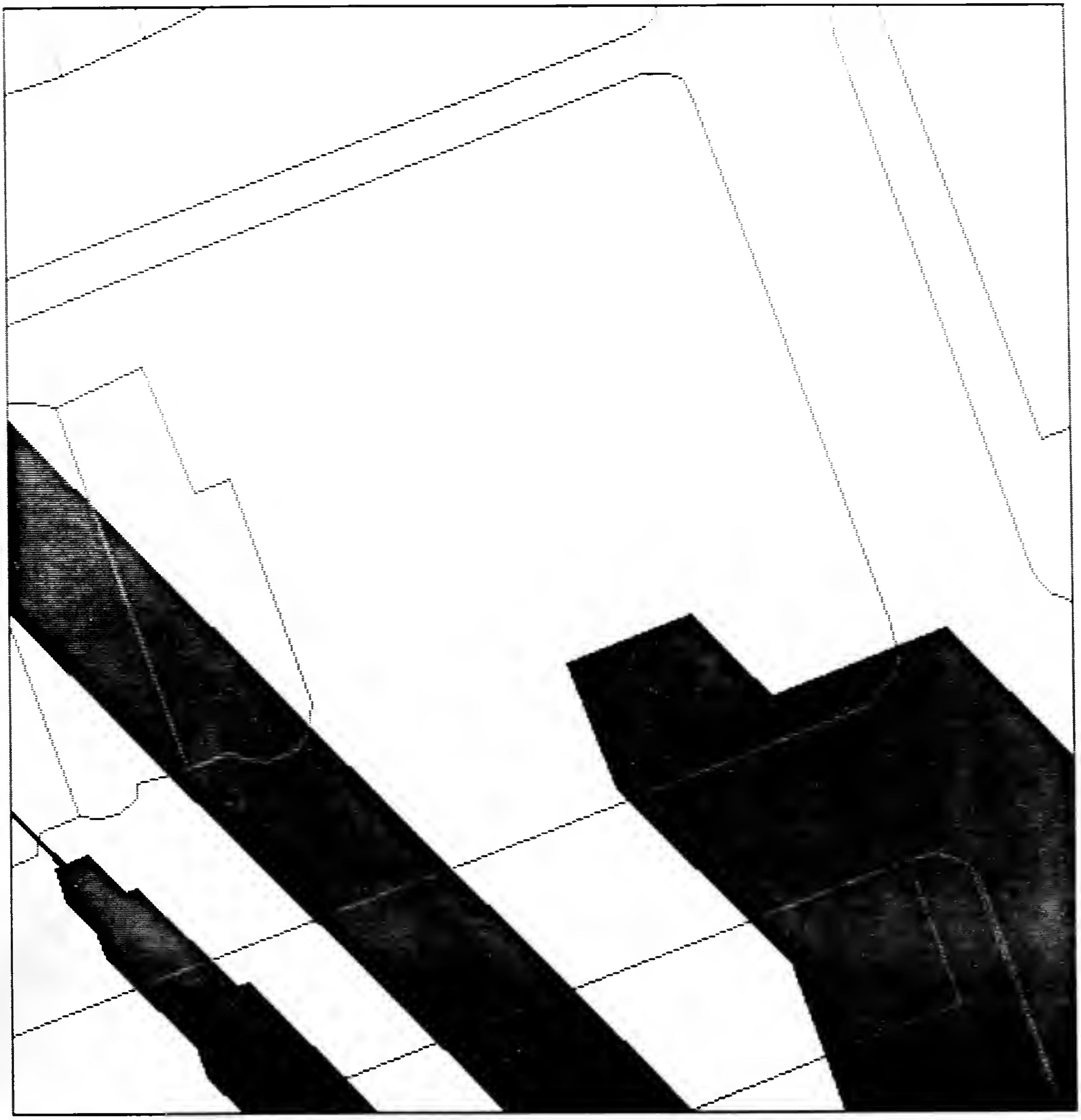
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

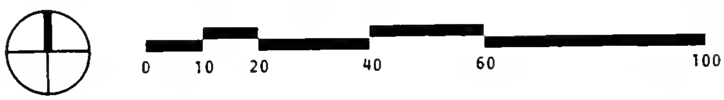
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

8 February 9:00am



Existing shadow

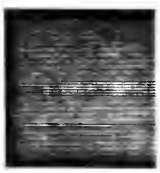
Incremental shadow
New England Life Project



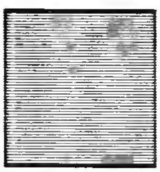
- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

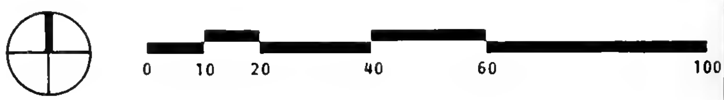
15 February 7:45am



Existing shadow



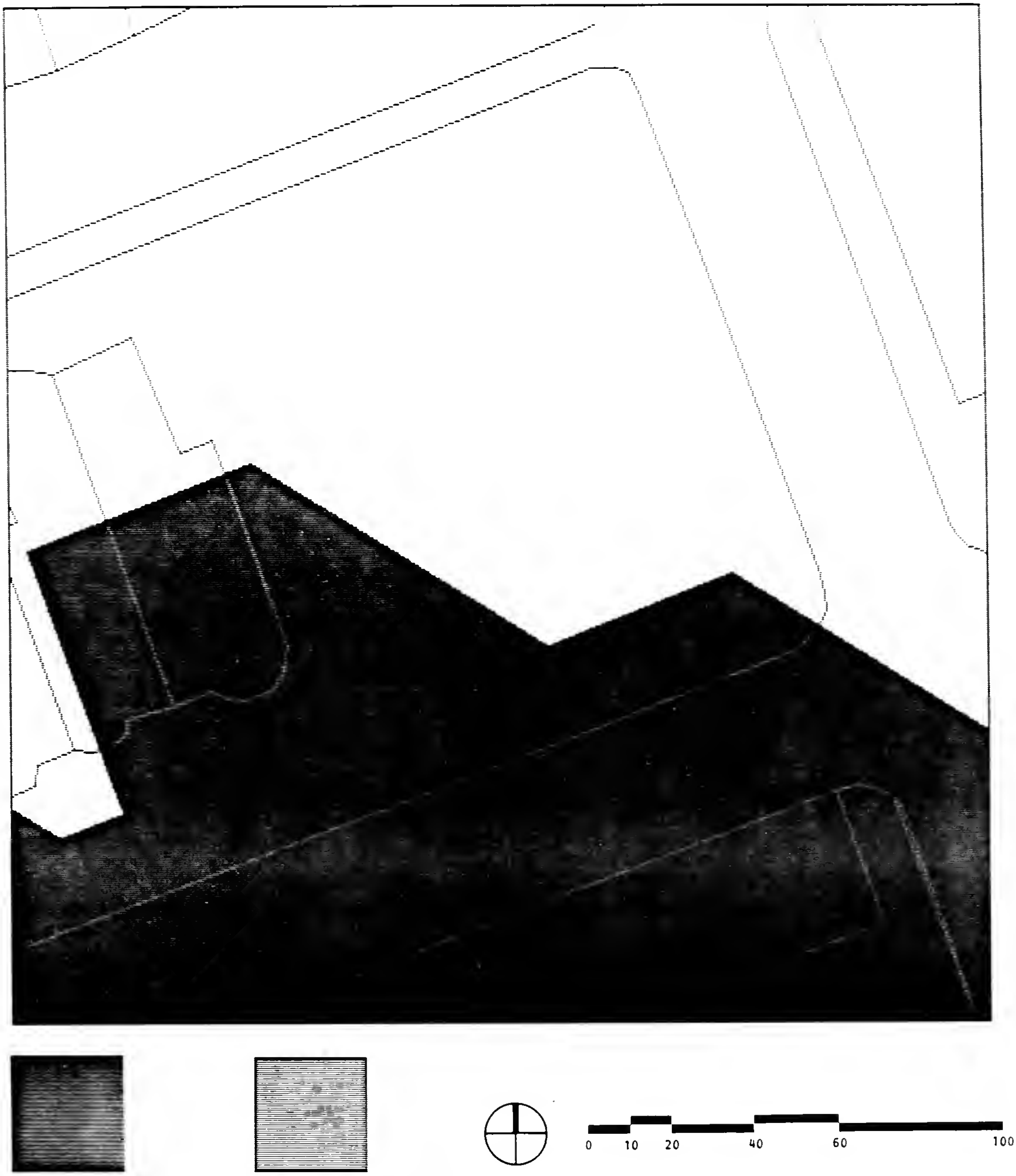
Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

15 February 8:00am



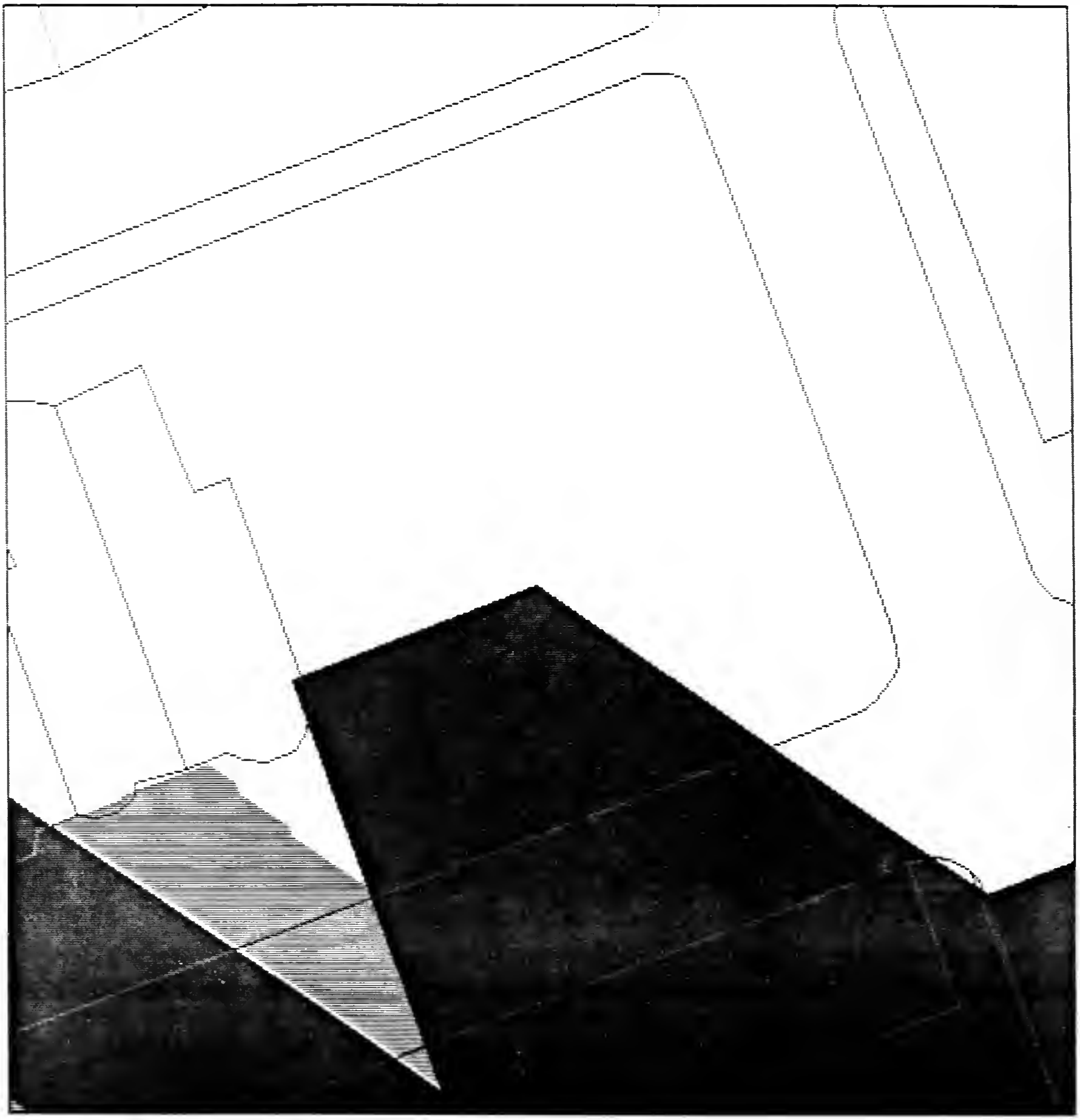
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

15 February 8:15am



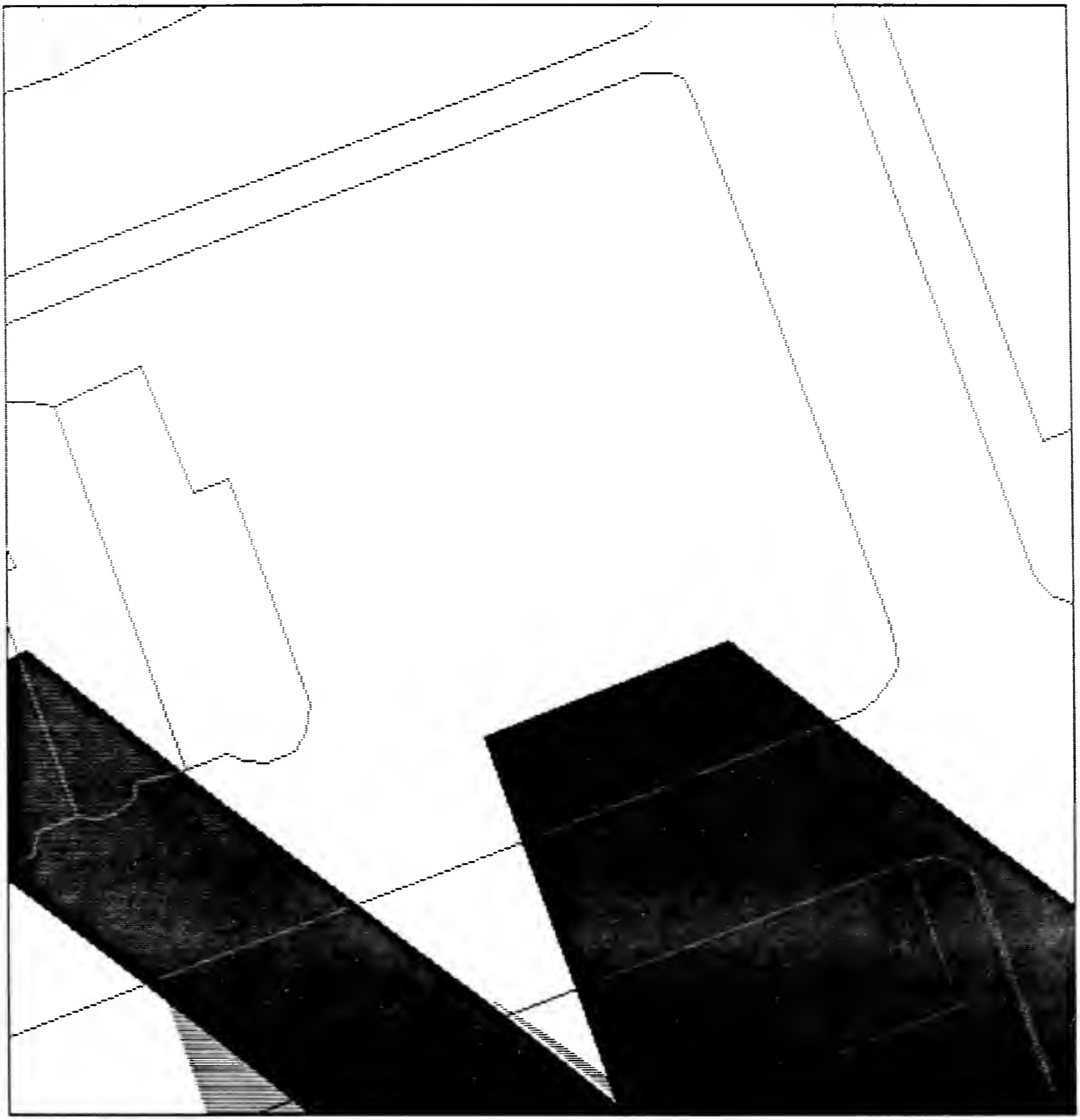
Existing shadow

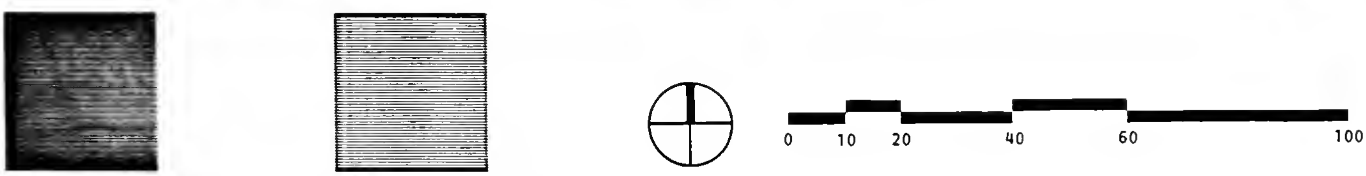
Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

15 February 8:30am





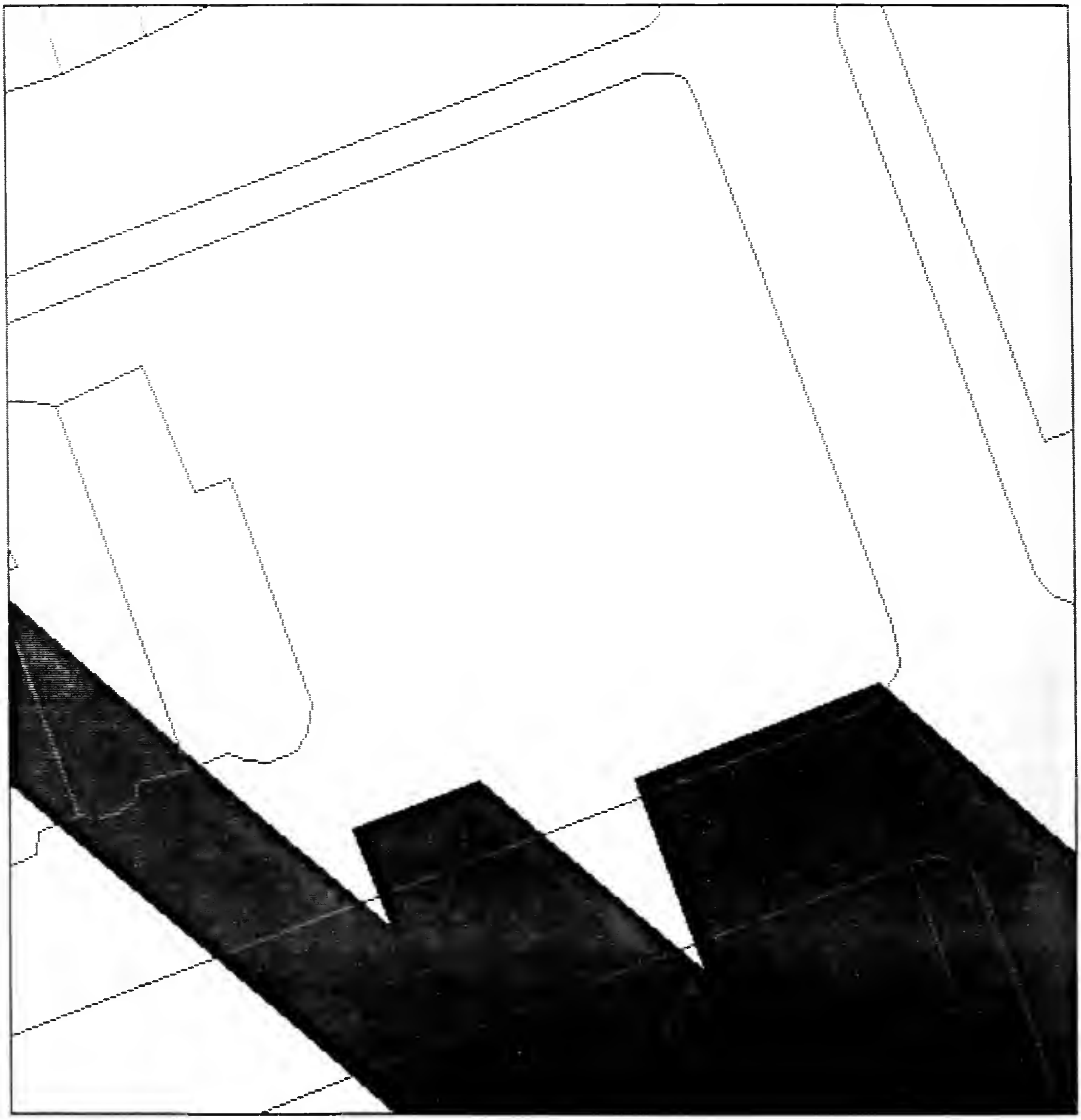
Existing shadow

Incremental shadow
New England Life Project

- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

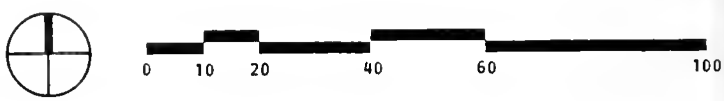
SHADOW ANALYSIS
CLARENDON STREET PLAYGROUND

15 February 8:45am



Existing shadow

Incremental shadow
New England Life Project



- All times are Eastern Standard Time.
- Analysis done for shadows cast on the ground plane.
- Shadows from trees along Commonwealth Avenue and the Clarendon Street Playground are not included in this analysis.

AUTHOR 500 Boylston Street Project	
TITLE	
DATE LOANED	BORROWER'S NAME

Appendix 5
Archaeology

500 Boylston Street Project

BRA Final Environmental Impact Report

February 1985

Submitted to	Boston Redevelopment Authority
Project Proponent	A Joint Venture of New England Mutual Life Insurance Company Gerald D. Hines Interests, Inc.
Prepared by	Skidmore, Owings & Merrill Vanasse/Hangen Associates, Inc. Haley & Aldrich, Inc. Tech Environmental Wright Brothers Facility, MIT Historic Preservation Planning & Analysis

Appendix 5
Archaeology

500 Boylston Street Project

BRA Final Environmental Impact Report

February 1985

Submitted to	Boston Redevelopment Authority
Project Proponent	A Joint Venture of New England Mutual Life Insurance Company Gerald D. Hines Interests, Inc.
Prepared by	Skidmore, Owings & Merrill Vanasse/Hangen Associates, Inc. Haley & Aldrich, Inc. Tech Environmental Wright Brothers Facility, MIT Historic Preservation Planning & Analysis

MICHAEL ROBERTS

HISTORIC PRESERVATION ANALYSIS & PLANNING

INTERIM REPORT

Reconnaissance Archaeological Study for the 500 Boylston Street Project

Compiled by:
Michael Roberts

Contributions by:

Dena F. Dincauze, Project Senior Scientist

Stephen Mrozowski, Boston City Archaeologist
Project Supervisor

Michael Roberts, Project Manager

Catherine Carlson, Research Assistant

Submitted to:
Gerald D. Hines Interests
462 Boylston Street
Suite 302
Boston, MA 02116

JANUARY 28, 1985

51 HOLLIS STREET • GROTON, MASS. • 01450 • TELEPHONE 617-448-2585

Table of Contents

Management Summary	1
I. Introduction	2
II. The Reconnaissance Study	3
III. Significance and Problem Statement	6
IV. Research Design	10

Management Summary

This Interim report is presented to assess progress to date of the Reconnaissance Archaeological Study authorized by New England Life and Gerald D. Hines for the 500 Boylston Street project.

The first two steps in the Scope of Work have been completed with the submission of this report. These were the extraction of two cores from Providence Street and their analysis at Brown University, and the completion of background research on coastal fish weirs throughout the world.

The analysis of the cores reveals the presence of a wide variety of environmental indicators as well as a suprising diversity in sediment textures. Our researchers are confident that a rich data set can be retrieved and that new insights and many surprises will result from the analysis of these data.

The analysis of the literature data base on fish weirs leads our research team to be cautious with regard to the fish weir concept until the full range of sea-level and embayment dynamics is understood through an accurate analysis of the feature's morphology, trapped sediments and other associated data.

The introduction to this report, written by the City Archaeologist, places the archaeological study in perspective with the 500 Boylston Street project. This is followed by a brief description of the project and its status. The heart of the report is the Significance Statement and Research Design prepared by the Project Senior Scientist. These last two sections are based on the results of the coring and literature research as well as on a wealth of previous experience and thought about the project by the Senior Scientist.

The Reconnaissance Study is not yet complete. The evaluation of construction methods that might be used by potential contractors is necessary before a work plan and budget can be realistically prepared. Once the research team understands the construction process more accurately, the size and method of sample extraction can be determined, as can the most practical approach to viewing the feature as it is exposed. When this final task is complete, the project's Final Report will be prepared and will contain a detailed work plan as well as a budget for implementing the research design.

It will be important to keep in mind that, regardless of the proposed work plan developed as a result of this study, conditions revealed in the field during implementation of the plan may preclude completion or require modification of parts of the proposed plan.

I. Introduction

By: Stephen Mrozowski, City Archaeologist
Project Supervisor

When I began my tenure as Boston's first city Archaeologist, my goal was to build bridges between the past and the future. I held the conviction that it was not inevitable that progress need move forward at the expense of the City's legacy. This conviction has remained firm since that time.

It is still my belief that it is the responsibility of government and the development community to work together with a common purpose in providing opportunity for the future while showing respect for the past. Boston's history is an illustrious one filled with famous individuals and events that have been global in their impact. Few argue with the need to preserve the heritage of the City's recent past. However, long before any European walked the shores of the Shawmut Peninsula another people lived and prospered in these regions. These Native Americans left behind a long and fascinating legacy of their own tha must not be squandered due to some antiquated image of them as a backward and uncivilized people. Few archaeological sites in the Western Hemisphere testify to the ingenuity and sophistication of these early Americans better than the Boylston Street Fishweir.

Part of the reason the Fishweir is so intriguing to archaeologists and laymen alike is its unique setting. Lying some thirty feet below the streets of the Back Bay is a Boston that is at least 5,000 years old; separated from us by time, but not space. There is however, no true boundary between the past which the Fishweir embodies and the future that the 500 Boylston Street Project symbolizes. There is only a process meant to reconcile the two. This interim report is the first step in that process. If the past is to be lost we must try to gain as much knowledge from it as is possible. As the City Archaeologist, I feel it is my responsibility to see this process to fruition.

II. The Reconnaissance Study

New England Life and Gerald D. Hines Interests have authorized the conduct of a reconnaissance archaeological study to develop realistic and reasonable costs and schedules for data recovery of those portions of the "Boylston Street Fish Weir" which may be destroyed by the construction of the 500 Boylston Street project. The scope of this study as approved is as follows:

SCOPE OF WORK
RECONNAISSANCE STUDY
500 BOYLSTON STREET PROJECT

1. Purpose

The purpose of this reconnaissance study is to acquire sufficient information to allow archaeologists and cultural-resource managers to develop an accurate budget estimate and work plan for data recovery of archaeological resources that will be impacted by the planned construction at 500 Boylston Street.

2. Step I

First step will be to acquire two 2 1/2-inch split spoon cores from separate locations along Providence Street within the areas marked on the enclosed map. The cores to be taken will be continuous from the top of the silt layer through the basal peat to the blue clay. Those cores will be forwarded to a specialist in pollen and other microfloral and -faunal analysis. The better of the two cores will be analyzed to determine which classes of microscopic archaeological data exist in a condition that would warrant their detailed analysis in the early stages of data recovery.

3. Step II

A critical step prior to data recovery is to gain a more thorough understanding of coastal fish weirs throughout the world so that form and function of the feature at the Boylston Street site may be better

understood and data-recovery planning can be adjusted as necessary on the basis of early excavation evidence.

4. Step III

At present it is not clear what construction techniques would be most appropriate at the 500 Boylston Street site. The technique(s) is used will have a direct effect on the proposed data-recovery strategies. Therefore, this step will see archaeologists who will be directly involved in the project meeting with a number of local construction contractors to discuss possible methods of construction.

5. Step IV

The fourth and final step of the reconnaissance will be the development of a detailed research design and a work plan to implement this research design that is based upon expected construction techniques and classes of data expected to exist within the site. Included with this work plan will be a detailed budget breakdown with all cost items.

Two cores have been extracted from separate locations on Providence Street under the supervision of Project Supervisor Stephen Mrozowski and laboratory personnel from the Department of Geological Science at Brown University. These cores have been moved to Brown University where they have been analyzed for presence or absence of data necessary for understanding the environment of the site under the direction of Dr. Thompson Webb. While a formal report on the analysis is not due until Feb. 1, verbal communications between the Senior Scientist and the analysts suggest the presence of a wide range of environmental indicators. This information has contributed markedly to the significance and problem statement for the feature, as well as allowing the development of a research design that is realistic in its expectations for answering critical questions about the feature.

A second component that has contributed to the development of the research design has been library research undertaken as a part of this study to gain a better insight to the form and nature of coastal prehistoric fish-weir complexes. This research, undertaken by a research assistant of the Senior Scientist, has helped to strengthen the working hypothesis as

well as to lay the groundwork for the analysis of the feature as it is encountered in the field.

This interim report is designed to assess progress to date and chart the course of work for the rest of the study. We have completed at this time Steps I and II of the Scope of Work. This allows us to prepare a comprehensive significance statement and to present a research design that realistically addresses those data that we now know exist within the site. While the preparation of the Research Design is Step IV of the Scope, to meet the needs of New England Life and Gerald D. Hines Interests we have prepared a detailed Research Design that describes in detail the research questions that will direct the course of the field work and the sampling strategies necessary to acquire enough material to be confident that analysis of these data will result in answers to the questions. What is not possible at this time is the development of a work plan that will allow the application of the Research Design to the actual field situation. This also means we are unable to give a realistic estimate of the time and cost of field work and analysis. Once Step III is accomplished, and taking into account the data already in hand, a detailed work plan and budget can be assembled.

III. Significance and Problem Statement

By: Dena F. Dincauze
Project Senior Scientist

The Boylston Street Fishweir, an archaeological feature approximately 4500 radiocarbon years old, is significant in North American prehistory as the earliest large environment-modifying facility known on the continent. Constructed by communities living a hunting-and-gathering lifestyle, it is surprising for its size and the implications of that size for human labor investment. Regionally, its significance derives from both its uniqueness as a site and for its cultural context--it belongs within the Late Archaic period (Dincauze 1973:31), a time when the northeastern hunter/gatherer peoples had achieved sufficient population density to support, and perhaps require, an unprecedented level of cultural complexity. Territoriality, subsistence diversification, and ceremonial elaboration characterize the fifth and fourth millennia before the present, yet prehistorians know little about the details of the lifestyles that supported such complexity within societies of temperate-forest wild-food gatherers. The site itself--a coastal facility 30 feet below city streets and offering excellent preservation of a suite of organic remains--is unique in regional archaeology, and is famous far beyond the region because of the high quality of the original investigations and the innovative research techniques applied. Local significance resides in the uniqueness and importance of the site itself, and in the fact that it may be the only ancient site on Boston Neck that is still accessible to investigation under any circumstance.

Research questions appropriate to a site of such significance must involve considerations of the structure's role within the human communities which produced it. Better understanding of the form, size, and function of the feature will lead to understanding the human motives, expectations, and effort that lay behind its construction. It may be possible to estimate the size and frequency of the work parties involved, and thus to gain some insight into the size of the community which the structure served. Historical and ethnographical sources provide very limited information on temperate zone hunter/gatherer societies, most of which are now extinct; archaeology offers the major source of whatever new information will ever become available. The Boylston Street feature is a precious instance of the preservation of some aspects of those data.

The earlier investigations of the feature, undertaken by interdisciplinary teams organized by Frederick Johnson through the R.S. Peabody Foundation for Archaeology in Andover,

Massachusetts, were focussed on understanding the age and environment of the structure. At the time, the two questions were inseparable, as the only time scale available for the Holocene was that based on the varve-dated Blytt-Sernander pollen episodes of northwestern Europe and their inferred climatic correlates. The several investigators placed the construction and use of the fishweir near the end of the post-glacial maximum warmth, and therefore estimated the age as about 3000 years. The structure or structures appeared to the researchers to have been placed, used, and abandoned over a fairly sort span of time--perhaps a century or so, at most. The human activity, then, was closely related to the unique environmental conditions of the site, at a time when the Back Bay was beginning to fill and to evolve from a brackish backwater into a tidal embayment in the Charles River estuary. The installation and the abandonment of the feature were both intimately involved with the environment at the site and its neighborhood, an environment about which we know many details, thanks to the initial investigations.

However, the Johnson team did not focus closely on behavioral issues--the construction or the function of the structure--although they raised the important questions about each topic. Such limitations are not surprising, given the constraints of access, time and funding under which the investigators worked, and the emphasis they apropriately placed upon dating the feature. Although the label of "fishweir" was retained in the conclusions and in the monograph titles, Johnson noted that the data from the site itself did not closely resemble the historical fishweirs he used as interpretive analogues (Johnson 1942:206-207). The limited area within which stakes were actually observed, the reliance upon construction crew observations to plot the greater part of the distributions, the difficulties of the site conditions at both the New England Mutual and John Hancock exposures, and the technological limitations of the time all militated against the retrieval of the empirical evidence needed to interpret the feature. It cannot be claimed, unequivocally, that we know the structure to have been built and to have functioned as a weir. What else it could have been is equally unclear. It does seem likely that the forest of stakes represents more than one construction episode, more than one discrete structure (Johnson 1949:3). A series of smaller constructions, replaced over time in the same locale, is more likely than a single, massive, thicket-like emplacement of stakes and wattles. Clarification of the functional issue must be one of the major thrusts of any reinvestigation.

The fishweir interpretation can be considered an hypothesis subject to test. The implications of the hypothesis will be explored below, in the research design. Any conclusion that the feature functioned as a fishweir would entail support from such

observations as the direction in which the current set against the stakes, the orientation of the stake rows in respect to the adjacent shore, the kinds of fish that could be expected in the bay at the time and their amenability to being taken in weirs, the season of use, frequency of rebuilding, and so on. The 1939 investigations disclosed that the 110 stakes examined had been cut in spring (April to June), a conclusion based on the state of the cambium layer under the bark. (Bailey and Barghoorn 1942:84). This was taken to imply construction of the feature in the spring, the correct season if spawning runs of anadromous fish were to be taken in weirs. However, the evidence to support the inference of spring construction (as distinct from the gathering of materials), and therefore implied function, is still missing.

The size of the feature, stretching from beyond Newbury Street to St. James Street on the north-south axis, is more than impressive. It raises questions about the environmental effect of the cutting and removal of at least two hundred thousand saplings, all of which must have been taken from an area not too distant from the site. The evidence of fairly rapid silting, and of an increase in grass pollen near the Bay during the time that the feature was in place (Knox 1942:108), raises questions about a possibly significant amount of deforestation in the immediate vicinity. One can imagine that the feature was ultimately abandoned because it was choked in silt and sand flushed in from degraded land surfaces adjacent the Bay--that the facility in effect was self-destructive. Study of the site can clarify these environmental issues, which so hauntingly echo some of our own modern dilemmas.

Only when the function, size, and cost of the feature can be estimated can an understanding be approached of the benefits expected by its builders. Such issues bear directly upon the size and structure of the hunter/gatherer communities inhabiting the Boston area 4500 years ago.

The water-logged organic sediments enclosing the site provide highly unusual preservation conditions. The wooden construction, the estuarine sediments enclosing it, and the plant and animal life that swarmed in the water in which it stood are all preserved in part for examination. The core inventory made at Brown University shows that the classes of data available now include abundant pollen, plant macro-fossils in discontinuous distribution, diatoms, molluscan shells, some foraminifera and ostracods, and more diversity in the sediment textures than had been expected on the basis of the earlier reports. Thus, the basis seems to be there for observing through time and space such environmental conditions as current directions, the temperature and salinity of the water, the changing shellfish fauna, the kinds of terrestrial plant materials being deposited in the bay, and the nature of the

plant communities fringing it. With the preservation of these several classes of organic materials demonstrated, there are grounds for expecting that careful observation and appropriate data collection techniques will yield some fish remains as well. Thus, a rich data set can be retrieved, and surprises can be expected as one class of data is compared to another and as new questions are put to all. It is not unreasonable, either, to hope that within the feature itself, the focus of so much human labor investment, we may find some tangible objects in addition to the stakes and wattles that were brought to the site by the human builders and attendants.

IV. Research Design

By Dena F. Dincauze
Project Senior Scientist

The investigations at the New England Mutual and John Hancock sites emphasized environmental issues for the reasons summarized above. The work done was of excellent quality--thorough and innovative. In the year's since, new methods and new questions have become available which, brought to the site, can elucidate other aspects of the ancient situation. In a reinvestigation of the site, environmental issues emphasized will be mainly those related to the stratigraphy and dating of several key events during the filling of the bay and to conditions on the immediately adjacent landsurfaces, as explained below. Some restudies will be required by the need for more rigorous sampling of data in both the horizontal and vertical dimensions. The emphasis of the new studies, however, will be on archaeological and anthropological issues, those related to the human activity at the site.

There are five major topics to be investigated: 1) the number of construction or repair episodes, 2) the form of the structure or structures, 3) the age and duration of the structure or structures, 4) the function of the structure(s), and 5) the labor investment in the construction. Within each topic there are a number of subsidiary questions, which can be addressed with data from several distinct sources and analyses. Some of the data will relate to more than one topic.

Topic 1. The complexity of the stake arrangements, the large number of stakes, and the size of the area over which they are distributed, as well as the evidence for at least two episodes of stake and wattle emplacement, led the initial investigators to conclude that the observed stakes and wattles were likely the remains of a palimpsest of different construction events. That conclusion seems to be the strongest one on which to proceed, and it will be the guiding hypothesis for the definition of this stage of the research design. The reverse hypothesis, that only one structure and one construction episode are represented, must be kept in mind but seems highly unlikely. Therefore, the feature will be approached with the expectation that more than one episode of construction, and perhaps several episodes of repair or maintenance, were involved. Evidence will be sought to test this expectation, by careful observation of the relationships between the lower ends of stakes and micro-stratigraphic horizons in the silts, by observation of the relationships among individual stakes in clusters, by plotting the distribution of as many stakes and clusters as are available for such study, by observation of the relationship of the

horizontal wattling to stratigraphic markers such as the shell layers or finer horizons, by observation of the barnacles and other fauna (e.g., marine borers) associated with the stakes , and by analysis of the tree-ring growth patterns within and between major clusters or alignments.

The sedimentologist will examine a number of vertical exposures. looking for changes in the structure and texture of the sediments, recording the succession of sedimentary events observed, and taking samples for textural analysis in the laboratory. Ideally, such observations would be made at intervals of about 30 feet along a continuous face, such as might be exposed serially along one or more of the excavation walls, or along blocks within the space. Such an interval would permit almost continuous plotting of sedimentary structures, and good control over spatial variation. Efforts will be made to distinguish in the field the surface or surfaces into which stakes were driven, by observing the differences between sedimentary layers distorted by insertion and those which accumulated around standing stakes. Observations must also be made of the relationships between stakes in situ and the growth of sessile fauna within the sediments and on the stakes. Should observation intervals be greater than the desired 30 feet, concommitantly more samples must be taken for laboratory analysis and comparison, in order to establish equivalences and differences over space. Control of microstratigraphy over space will require that the stratigraphy of microfossils be closely related to the sediments, and that some heavy mineral analyses be made to identify control horizons.

The study of tree growth-rings will require samples of 50-100 stakes from each of two or more discrete clusters or locations in the silts between Clarendon and `Berkeley Streets. Patterns of growth-ring will be plotted for the stakes , and compared within and between the groups by computerized pattern-analyses. It should be possible to determine whether all the stakes were cut at one time (in one year) or in different years. Inter-group diversity would imply the assembling of materials for, and perhaps construction of, different parts of the feature at different times. Observations of intra-group diversity would imply either that groups were subject to the episodic addition of stakes for maintenance or repair, or that stakes were stockpiled over years in anticipation of future use. It is not expected that any annual chronology can be developed from the tree rings, because of the small size of the stakes and the environmental complacency of most Northeastern tree species. Given the expectable constraints on the investigation, no expectation can be entertained of achieving a total count of episodes; it will be sufficient to know whether there were only one, more than one, or several observed construction episodes.

<u>Topic 2</u>. Information about the form of the structure or

structures will be sought by various means, including the answers to the questions in Topic 1. Ideally, all extant stakes and wattled areas within the excavation would be plotted by exposing and photographing the elements; the known condition of the site, with dense pilings and caissons beneath the standing buildings, militates against any approximation of this ideal. Nevertheless, as much detail as can be achieved should be diligently sought. Depending upon the amount of area exposed to investigation and the portion of the whole that it represents, statistical tests such as spectral analysis might be informative about patterns in the stake distributions. At the least, plotted areas can be compared to information recovered from the literature search of prehistoric, ethnographic, and modern tidal fishweirs. During exposure of the area east of Clarendon Street, a search will be made for more ephemeral components of the structure--traces of netting, mats, or basketry such as might be associated with a weir or fish trap.

The relationship of the stake groups and alignments to the ancient topography of the bay area will also be important. The topographic reconstructions offered by Judson in 1949 (pp 28,48) were considered provisional; it is not really surprising, therefore, that there are discrepancies between Judson's text and the maps with which he illustrated it. It is likely that information from additional borings taken since that time can refine the picture. It should then be possible to confirm whether or not the stake alignments were emplaced across a bar-like rise in the floor of the bay, as appears in the Judson map (1949:28), and what was their orientation to the coeval shore of the bay. The question of whether the "Shell Layers" represent mudflats, formed when the siltation rate was low or negative, needs to be answered if possible.

The preliminary literature search on historic, prehistoric and ethnographic weirs has highlighted a significant contrast between weirs built on coastal tidal flats and those in rivers, whether estuarine or note. It becomes important, therefore, to know whether the Charles River was flowing across the ancient Bay itself, or was blocked outside of it, to the north. The ambiguities in the paleotopographic maps, alluded to above, prevent any sound assessment of the situation without more data.

The vexing question of the tidal range at the time, and the location of mean tidal level in relationship to the structure, must be reopened. Investigators working since the Johnson team of 1939 (Judson 1949:45; Kaye and Barghoorn 1964; etc.) have accepted as working hypotheses the estimates of tidal rage and mean offered very tentatively at that time (Johnson 1942:162). The reservations entertained by Johnson (1942:164-7) about the reality of these figures are valid. The assumption that the modern tidal amplitude can be used as an analogue for prehistoric amplitudes was current as recently as 1970 (cf.

Dincauze 1973, Kaye and Barghoorn 1964); more recent work has demonstrated that tidal ranges in the mid-Holocene were almost certainly lower than those of recent centuries, for many good geophysical reasons (Bloom 1983, Grant 1970), not the least being the position of the Bay near the shoreward tidal limits. The very detailed stratigraphic investigations proposed here are likely to contribute essential data toward solving both the topographic and the tidal problems, by contributing information on the direction and force of currents in the bay, and on bottom conditions, at the times of construction, use, and abandonment. Modern methods of sea-level modeling should help to clarify the ancient situation.

Macro-botanical studies will examine stakes and wattles for the species of trees utilized for each component (stakes, wattles) of the structure, with the hope of achieving a statistically valid sample of the range, which was not accomplished in the earlier investigations. Such information would be necessary to evaluate the effect of the stake cutting on the adjacent uplands.

<u>Topic 3</u>. The questions of the age and duration of use of the structure, which caused so much trouble to the original investigators, may be answered with new analytical techniques unavailable before in conjunction with the new information on the construction and form of the feature. The relationship of structural elements to sedimentary episodes will be revealed in the vertical cuts and by laboratory analyses of sediment particle-sizes and possibly chemistry, by study of the sedimentary structures, by stratigraphic episodes defined by micro-organisms, and by the pollen stratigraphy. The stratigraphical relationships are, of course, equivalent to relative ages. It is expected that a fairly fine-grained chronology of the lower silts can be achieved, to which construction and abandonment of the structural elements can be associated.

Ordinary radiocarbon dates, which have already revealed the approximate age of the structure, the Lower Peat, and of the silts above the structure (Arnold and Libby 1941:113; Byers 1959:242; Kaye and Barghoorn 1964:74) do not give results sufficiently accurate to distinguish events within units of time less than a century. More refined dates are achievable with the new accelerator techniques. It should be worthwhile to select a few critical samples for accelerator dating, as detailed below, in order to estimate rates of siltation and to control the dates of construction and abandonment more closely than would be otherwise possible.

The construction date or dates of the feature (as distinct from season) can be approximated by the cutting dates of stakes. In this regard, it might be useful to select both early and late

stakes (i.e., those emplaced into lower and higher sedimentary layers, respectively) and lower and upper wattle, to see whether the time intervals can be discriminated by radiocarbon methods. It is to be noted here that if seepage of petrochemicals or other urban pollutants into the silts has occurred, any radiocarbon samples would require exceptional pretreatment, and may be contaminated beyond usefulness.

The abandonment of the structures might be dated by the ages of shellfish growing near the cut-off tops of stakes or at the upper surface of the upper wattle. Such a date would, of course, exaggerate the abandonment somewhat, as the position of the organism would represent a time after the feature had become uselessly choked with silt. If shells are to be used for dating, there would need to be a correction factor established against more reliable wood dates. This might be accomplished by dating shell closely associated with the surface of insertion of stakes, and taking any difference to be the correction factor to be applied to shell dates.

These considerations are somewhat speculative, of course, since the accuracy of any radiocarbon assays may be insufficient to answer the questions raised. However, with accelerator dates having relatively small (+/- 40 years [University of Toronto]) error ranges, it seems worth trying, even though this means that the dates would have an 80-year envelope of uncertainty. Judgement of the suitability of such analyses could be delayed until the more qualitative age estimates had been approximated, as long as suitable samples were taken during field studies.

Topic 4. The problem of the function of the structure or structures, that is whether fishweirs or some other kind of facilities, will be investigated in terms of the answers to questions posed under topics 2 and 3, and by research into water conditions, climate, and paleontological remains. The full power of interdisciplinary research will be needed to address this issue successfully. The changing temperature, salinity, and hydrodynamics within the bay would have been primary controllers of the kinds and numbers of fish there, as they were also for the sessile fauna and the microfauna. Such changes, as well as changes in the sources of water entering the Bay (i.e., the contributions of the Charles River vs the Harbor tides) can be reconstructed through data realized from the sedimentary, microfossil, and topographic studies.

Paleotemperatures can be reconstructed from the associations and stratigraphic relationships of different species of such small organisms as diatoms (microscopic siliceous plant remains), ostracods (tiny calcareous bivalves, predators of diatoms), and foraminifera. The later, derived mainly from the open sea, were rare in the core examined at Brown, and are not expected to contribute significantly to the present study. Ostracods can provide more information of immediate relevance. Paleotemperature information can also be obtained from a study of the relative proportions of isotopes of oxygen in the shells of molluscs or zooplankton. A few such determinations might be useful checks on the diatom data should the latter prove scanty, but if the diatom and ostracod studies have data enough, the isotope analyses may not be needed.

Paleotemperatures on the land can be approximated by the pollen studies, using transfer functions to estimate the range of temperatures represented by the association of plant species. Terrestrial beetles, if encountered in the silts as well as in the lower peat (where they were recognized but not studied in the earlier investigations) can be very informative about air temperatures. Should the need arise, air temperatures, seasonal contrasts, and available moisture can be studied by the analysis of stable carbon isotopes in the wood of the stakes.

The earlier studies demonstrated a change in the temperature and salinity of the water, notably above the level of the second Shell Layer (Nelson 1942:61). Salinity of the water, and thus the relative contributions of the sea and the rivers, can be traced through time in the changing diatoms and ostracods. This should correlate with the changing levels of the tides, and the landward extension of the tidal zone itself, since the contribution of the river would become less through time as the sea rose and became the dominant source of water in the Bay.

However, the initial particle-size studies indicated that many

other changes in the hydrodynamics remained unexplained. The core examined at Brown shows more changes in the alternating dominance of silt and sand particles than had been anticipated from the literature. Therefore, the pulses in the rate and texture of sedimentation need to be examined against the changing salinity, as well as against the changing topogaphy relative to sea level, in order to see how they might be best explained. Pulsing in the rate and grade of sediments entering the Bay could have had a number of causes. The fact of change would have affected people gathering food from the Bay, as the quantity and quality of fauna in the water would have responded to such changes. Some of the change no doubt resulted from changing climate (temperature or precipitation) at the end of the post-glacial optimum, and some from the effects of the marine transgression, whether that was ultimately eustatic or isostatic (Bloom 1983; Kaye and Barghoorn 1964).

It must be kept in mind that some of the changes may well have been induced by human activity. The early investigators noted that the existance of the wattling would have slowed the currents in the Bay, inducing the deposition of coarser material (Stetson and Parker 1942:43). The existance of the stakes and wattling provided conditions conducive to oyster growth, and the growth of the oyster bed further interfaced with the currents (Nelson 1942:60). the activities of people on the adjacent land surfaces might also have affected the local hydrography and topography. Deforestation resulting from the cutting of so many thousands of saplings for the construction of the feature (note that grasses peak between Shell Layers 1 and 2 [Knox 1942:109]) could well have resulted in a locally lowered water table, induced erosion of the land, and the subsequent deposition of silt and sand into the Bay by inflowing streams. Other human activities (e.g., fires), could have had similar effects. Observations to be made in the silts--of sand lenses, charcoal concentrations, etc.--may help to discriminate among some of these possibilities, and clarify further the interactions of people and their environments in antiquity.

The reconstruction of hydrodynamics will be important in assessing whether or not the currents impinging upon the lines and clusters of stakes were appropriate for the constructions to have served to trap free-swimming fish. Observation of micro-structures in the sediments such as current ripples, and the upstream-downstream contrasts of deposition against the stakes and wattles, will be important here.

Such studies of the aquatic and terrestrial environments should help to narrow the range of possible functions for the structures. Further clarification can be expected from paleontological study of the sediments directly associated with the stakes. Water-screening of the sediments will be undertaken to recover the remains of shellfish, barnacles, and fish (bones and scutes) that died or were deposited near the stakes and wattles. These can be evaluated against their depositional environments (particle-size, relationship to current direction, etc.) to judge whether their occurrence might be attributed to a functional relationship with the stakes, rather than merely a depositional one.

Watch will be kept, in addition, for any artifacts or other materials that might have been dropped or placed among the stakes by the people who erected or utilized them. For instance, both of the RSPF monographs record the presence among the stakes and wattles of cobbles (Johnson 1942:14, 1949:60). The investigators were inclined to attribute no significance to them (Johnson 1942:28). However, the facts that they occurred at both sites, that in the two illustrated instances (Johnson 1942: Plate II, 1949:60) they were at the level of the brush and stakes, and their sizes ("up to 6 inches"; "6-7 pounds") in a depositional environment characterized by much finer materials, could imply their status as manuports--material brought to the site by human agency. It is not unlikely that such objects were useful to the builders in the process of hammering stakes and ramming the wattling down among the stakes, and it is also possible that they could have helped to anchor the buoyant branches underwater. Archaeologists, of course, retain the hopethat some artifacts diagnostic of their makers might be found among the stakes, to implicate the cultural group responsible for the construction.

<u>Topic 5</u>. The ultimate question--the labor cost and the possible benefits of the feature(s) to the community that constructed it, will be answered in terms of the answers to the first four questions, and of any observations of construction details and possibly associated artifacts made during exposure of the structure(s). Estimates of the labor required to build selected segments or samples of the feature will be attempted, in order to estimate at definable levels of confidence the

requirements of the totality as that may be accessible to the investigators. Such information will enable archaeologists to infer something significant about the marshalling and organization of labor by hunter-gatherer communities near Boston, their minimal requisite numbers, and the size of communities supporting such an undertaking. Should the feature appear to be a single construction, the implications for labor force could be surprising. Should the feature prove to be the sum of a large number of episodical efforts of a small number of people, then current concepts of community size would require no modification, but ideas about seasonal work-force, activity scheduling, territory size, and storage capacity would require attention, thought, and research at other sites.

The labor Estimates would involve consideration of the energetic requirements for selecting cutting, trimming, transporting, and emplacing the stakes in a sample parcel of the structure, with appropriate adjustments according to whether the stakes and wattling in the parcel are judged to have been cut and emplaced at one or more times, into what depth of water, etc. Knowledge of conditions on the adjacent land would be necessary to permit estimates of the availability of saplings of the appropriate sizes, and the amount of territory necessary to produce them. None of the quantities desirable for such estimates can be rigorously specified under the conditions in which this investigation will take place, but it is likely that enough information can be attained to permit some mathematical modelling.

Comments. The research questions and the activities to be undertaken to address them, as presented above, must be parcelled out to a number of different researchers in a series of definable tasks. However, until there is specific information about the procedures for excavating the building foundations, and therefore about the conditions and schedules under which access to the sediments will be possible, no additional specificity can be developed.

REFERENCES CITED

Arnold, J. R., and W. F. Libby
1951 Radiocarbon Dates. Science 113:113.

Bailey, I. W., and E. S. Barghoorn, Jr.
1942 Identification and Physical Condition of the Stakes and Wattles from the Fishweir. In Johnson, 1942:82-89.

Brown, Arthur L.
1983 Sea Level and Coastal Changes. In Late Quaternary Environments of the United States, Vol 2, The Holocene, edited by H. E. Wright, Jr., pp 42-51. University of Minnesota Press, Minneapolis.

Byers, D. S.
1959 The Eastern Archaic: Some Problems and Hypotheses. American Antiquity 24:233-256.

Dincauze, D. F.
1973 Prehistoric Occupation of the Charles River Estuary: A Paleogeographic Study. Bulletin of the Archaeological Society of Connecticut, No. 38:25-39.

Grant, D. R.
1970 Recent Coastal Submergence of the Maritime Provinces, Canada. Canadian Journal of Earth Sciences 7:676-689.

Johnson, F., editor
1942 The Boylston Street Fishweir. Papers of the Robert S. Peabody Foundation for Archaeology, Vol. 2. Phillips Academy, Andover, Mass.

1949 The Boylston Street Fishwir II. Papers of the Robert S. Peabody Foundation for Archaeology, Vol. 4. No. 1. Phillips Academy, Andover, Mass.

Judson, S.
1949 The Pleistocene Stratigraphy of Boston, Massachusetts, and its Relation to the Boylston Street Fishweir. In Johnson, 1949:7-48.

Kaye, C. A., and E. S. Barghoorn
1964 Late-Quaternary Sea-Level Change and Crustal Rise at Boston, Massachusetts, with Notes on the Autocompaction of Peat. Bulletin of the Geological Society of America 75:63-80.

Knox, A. S.
1942 The Pollen Analysis of the Silt and the Tentative Dating of the Deposits. In Johnson, 1942:105-129.

Nelson, T. C.
1942 The Oysters. In Johnson, 1942:49-64.

Stetson, H. C., and F. L. Parker
1942 Mechanical Analysis of the Sediments and the Identification of the Foraminifera from the Building Excavations. In Johnson, 1942, 41-44.

AUTHOR

500 BOYLSTON STREET PROJECT:

TITLE

DATE LOANED	BORROWER'S NAME